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ELECTRO-OPTICAL/METEOROLOGICAL SIMULATION MODEL

Jack R. Stickel, Major, USAF

Det 4, 11 WS

AUGUST 1985

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19. Abstract: Describes results of a pilot study to simulate electrooptical and meteorological variables; based on the NATO Optical Atmospheric Quantities in Europe (OPAQUE) project. The E-O/MET simulator generates simultaneous synthetic measurements of: visual attenuation, visual extinction, infrared transmittance, cloud cover, wind speed, relative humidity, temperature, dew point, and aerosol infrared extinction. The pilot study involved two distinct steps: (1) A data study to investigate the underlying probability distributions, serial correlation, and cross-correlations of key weather and electrooptical variables, and (2) Building and testing a simulation model based on the results of the data study. The data analysis includes both raw and derived variables. → p. vi

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PREFACE

This report describes the statistical analyses of the NATO Optical Atmospheric Quantities in Europe (OPAQUE) site at Ypenburg, the Netherlands, and the environmental simulation model developed from those analyses. The work was done under USAFETAC Project 2809.

The author gratefully acknowledges the numerous suggestions and contributions of Major Albert Boehm, USAFETAC/DNM, and Dr Louis Luempert, USAFETAC/DNY. He also acknowledges Lt Barry Coble, USAFETAC/DNY, for his help in developing the chapter on probability plots. Thanks also to Staff Sergeant Susan Ramsay, USAFETAC/DAW, for the many hours she spent typing this report.

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CHAPTER 1

INTRODUCTION

1.1 Need for Simulation of Electro-Optical and Meteorological Variables. Air Force Global Weather Central (AFGWC) Program Action Directive (PAD) 80-1 required a survey of environmental simulation customers to determine their requirements for the next 5 years and provide at least an idea of their needs for the 5-10 year time frame. The USAF Environmental Technical Applications Center (USAFETAC), Environmental Simulation Section (DNY) conducted that survey in September 1981. One of the major points noted in survey replies was that there is a definite need for simulation of specific optical and infrared variables over the limited range and time interval that weapon systems are employed. Army units, such as the United States Army Missile Command Research Directorate (Redstone Arsenal, AL) and Headquarters TECOM Systems Analysis Division (Aberdeen, MD), were particularly interested in simulation of infrared variables.

Simulation of electro-optical and meteorological (EO/Met) variables has a wide range of applications to Air Weather Service (AWS) customers. Weapon systems effectiveness studies, design trade-off analyses, combat tactics simulation, strategy and doctrine development, war games, and similar activities often need some kind of weather input. Simulation of EO/Met variables offers a practical alternative to the large numbers of actual observations previously required as inputs to these models. Environmental simulation models incorporate historical weather records through such statistical methods as probability distribution and correlation. These simulation models can produce synthetic observations much like real ones, and add the desired risk statistics called for by the designer or planner.

Shields (1981) and Janssen/van Schie (1981) have done detailed analyses on the frequency of occurrence for selected EO/Met variables within the framework of the NATO Optical Atmospheric Quantities in Europe (OPAQUE) program. USAFETAC/DNY takes the frequency of occurrence analysis one step further by mathematically modeling the cumulative frequencies for use in an environmental simulation model. This publication is one of the first complete statistical analyses of simultaneous observations of EO/Met variables. Although not a requirement of this project, linear regression equations developed as a by-product of the statistical analyses are also presented.

1.2 The NATO OPAQUE Program. An effective statistical study of EO variables requires simultaneous measurements of visibility in both the visible and infrared wavelengths. While there have been a number of studies of EO elements in different meteorological conditions, the OPAQUE project is the first extended collection of simultaneous observations. Initial OPAQUE plans called for a measurement period of 2 years, but several OPAQUE locations have considerably more observations.

The OPAQUE program was organized under the Defense Research Group of the North Atlantic Council NATO. A series of Research Study Groups (RSGs) under that council developed the joint measurement program for the European theater. RSG-3 of Panel III, Sky and Terrain Radiation, submitted the original proposal for an OPAQUE measurement program in November 1973. NATO publication OPAQUE D-7302 (Fenn, 1978) describes the measured elements, the measurement sites, the measurement schedule, and data format for this plan. Recommended locations for EO/Met measurements were (Fenn, 1978):

Northern Norway
Netherlands (urban area)
Northern UK
Denmark
Northern Germany (near eastern border)
Southern Germany
German urban industrial site
Northwest France
Southern Italy
Mediterranean Sea
Mountain site (Alps)

Site selection depended first on military tactical considerations; second, on how well the sites represented the locations in terms of geographical environment and meteorological conditions; and third, on the availability of logistic support. RSG-8 of Panel IV, Atmospheric, Optical, and IR effects, selected seven sites for the measurement program:

Danish/Canadian Station - Lolland, Denmark
French Station - Bruz, France
German Station - Birkhof, Germany
Italian Station - Trapani, Italy
Netherlands Station - Ypenburg, Netherlands
UK Station - Christchurch, England
US/German Station - Meppen, Germany

Figure 1. Map of Europe Showing the Northern OPAQUE Locations.

Figure 1 shows the locations of the OPAQUE measuring sites. With the exception of Trapani, Italy, all OPAQUE sites were built and installed during 1976 and 1977, and have been recording observations since the winter of 1976-1977. NATO OPAQUE D-8102 (1981) of the RSG-14, Panel IV contains the measurement codes and format specifications for the OPAQUE data tapes.

1.3 Pro' .t Requirements. In February 1982, the Air Force Geophysics Laboratory, Optical Physics Division (AFGL/OPA), requested that USAFETAC/DNY investigate the statistical relationships of the EO/Met variables at a suitable OPAQUE site. An environmental simulator would follow based on the results of that investigation. The statistical analyses and simulation modeling, where possible, were to be within the framework of the environmental simulation techniques described in USAFETAC TN-82/004, Basic Techniques in Environmental Simulation. The developed simulator would then be tested for transportability at a second OPAQUE location.

The Ypenburg, Netherlands, and Christchurch, England, OPAQUE locations were selected for analysis because of the number and completeness of available data. Ypenburg contains 47 months of data (from March 1977 to February 1981, excluding June 1980). Christchurch contains 27 months of data (from December 1976 to February 1979).

Ypenburg (52° 03' N, 4° 22' E) is located about 7 km southeast of Hague, The Netherlands, and 10 to 15 km northwest of R..terdam. The site is strongly influenced by artificial illumination at night. The Physics Research Group of the TNO Physics Laboratory managed the OPAQUE measurement program at the Netherlands site. Ypenburg is representative of the urban industrial environment of northern Europe.

The UK OPAQUE site is located at a site of the Royal Signals Research Establi hment at Barnsfield Health, near Christchurch, about 8 km inland from the south coast of England (50° 44' N, 1° 45 W). Christchurch is representative of northern Europe's maritime environment.

The EO/Met elements to be investigated were visual attenuation and visual extinction in km^{-1}, infrared transmittance in the 3.4 to 5.0 and 8.0 to 2.0 micron bands as percent transmission, cloud cover in octas, wind speed at 10 and 2 meters in $msec^{-1}$, relative humidity in percent, and temperature/dewpoint in degrees celsius. Aerosol concentration data would have been used but were not available for the present study. Such aerosol measurements were made by the TNO, and are described in a report by Hemmes (1982). Derived quantities such as aerosol infrared (IR) transmission and equivalent aerosol IR extinction proved more valuable than the actual transmittance observations for comparing the visual and infrared visibilities. Other variables in the OPAQUE data base could be adapted to a similar type analysis. AFGL/OPA provided the OPAQUE data tapes for the projects.

1.4 The Electro-Optics/Meteorology Simulator. The remainder of this technical note consists of descriptions of the OPAQUE EO/Met variables used in the project, the key concepts in statistics and simulation, the environmental simulation models used by USAFETAC, the statistical analyses of EO/Met variables in the OPAQUE data, and the two EO/Met simulators developed for this project. Chapters 2 through 7 are organized as follows:

Chapter 2--The meteorological and electro-optical variables. Includes both the raw variables and derived variables, such as equivalent aerosol IR extinction used to develop the simulator.

Chapter 3--Basic techniques in environmental simulation. Includes the basic statistical concepts of simulation, the single-variable, single-station model (V1S1), the two-variable, single station model (V2S1), and Multivariate Triangular Matrix model (MULTRI).

Chapter 4--Cumulative distribution functions of the electro-optical and meteorological variables. Covers the standard USAFETAC cumulative distribution modeling functions, evaluation of cumulative distributions, conversion of raw probability to a normal probability, and line segment fitting.

Chapter 5--Correlation coefficients. Covers the correlation coefficient development, the effect of random error of observation on correlation, and the serial and cross correlation of the OPAQUE variables.

Chapter 6--The electro-optical/meteorological simulator. Describes the two simulators (EOMETS1 and EOMETS2) developed for this project, and the transportability of the simulators to other locations.

Chapter 7--Linear regression analysis for the OPAQUE Ypenburg data.

CHAPTER 2

THE METEOROLOGICAL AND ELECTRO-OPTICAL VARIABLES

2.1 General. Table 1 gives the OPAQUE EO/Met variables used for this project, the measuring instrument, the measurement units, and the estimated measurement error (Fenn et al, 1979). The meteorological observations are on the hour. The electro-optical measurements span a period of time following each hour, ranging from 4 minutes at Ypenburg to 10 minutes at Christchurch. The visual attenuation/extinction measurements contain the beginning, ending, maximum, and minimum values for the measurement cycle. The beginning and ending values are occasionally the maximum or minimum values. The 3.4-5.0 micron band has both a beginning and ending value, while the 8-12 micron band has only the first reliable observation within the period. To allow for the best statistical comparison between the visibility and meteorological elements, USAFETAC/DNY chose the beginning visibility observations to develop the probability distributions.

TABLE 1. Measured OPAQUE Variables Used for Analysis.

Variable	Instrument	Units	Accuracy
Visual Scattering Coefficient Photopic Visibility	Nephelometer AEG Point	km^{-1}	±20%
Infrared Transmittance Photopic	Transmissometer Eletro	km^{-1}	±10%
Infrared Transmittance 3.4 - 5.0 microns	Transmissometer Barnes	%	±2%
Infrared Transmittance 8.0 - 12.0 microns	Transmissometer Barnes	%	±2%
Cloud Cover	Visual	octas	-
Temperature	Aspirated	°C	±.2°C
Relative Humidity	Hair Hygrometer	%	±5%
Dewpoint	Lithium-Chloride	°C	±1°C
Wind Speed at 10m and 2m	Cup Anemometer	$msec^{-1}$	±2%
Rain Rate	---	$mmhr^{-1}$	
Rainfall	---	$mmhr^{-1}$	

Observations containing rainrate, rainfall, or missing rainrate/rainfall observations were not included in the project. This is consistent with other OPAQUE analyses (Shields, 1981). The scattering properties of precipitation are significantly different from that of aerosols, thus producing an unknown bias in the statistical relationships. The total number of observations deleted from each hour's data is small, averaging 10 to 15 observations per 1-hour time bin. A separate analysis for rain cases is not possible for such a small number of observations. Appendix C contains the number of omitted rain case observations.

Each OPAQUE site took measurements in Mean Solar Time (MST), where mean solar noon is the time at which the sun reaches its zenith. This allows comparison between measurements at different OPAQUE locations. The MST for Ypenburg is 17 minutes 28 seconds in advance of Greenwich Mean Time (GMT), while Christchurch is 7 minutes behind GMT. Table 2 shows the Ypenburg sunrise and sunset MST for selected dates. These times were used to explore solar influences on different combinations of hourly groupings of observations.

TABLE 2. Ypenburg (52° 03' N, 4° 22' E) Sunrise and Sunset Mean Solar Time (MST) for Selected Times (after the Air Almanac, 1983).

DATE	SUNRISE	SUNSET	DATE	SUNRISE	SUNSET
Jan 1	0751	1542	Jul 1	0337	2006
Jan 15	0745	1600	Jul 15	0340	2000
Feb 1	0724	1630	Aug 1	0404	1934
Feb 15	0659	1658	Aug 15	0426	1908
Mar 1	0633	1721	Sep 1	0452	1834
Mar 15	0559	1746	Sep 15	0516	1759
Apr 1	0519	1815	Oct 1	0542	1722
Apr 15	0448	1840	Oct 15	0606	1650
May 1	0415	1907	Nov 1	0637	1615
May 15	0351	1929	Nov 15	0701	1553
Jun 1	0329	1952	Dec 1	0727	1536
Jun 15	0322	2004	Dec 15	0744	1532

2.2 **Meteorological OPAQUE Data.** The Ypenburg measured moisture element is relative humidity, while that of Christchurch is dewpoint temperature. The relative humidity must be converted to dewpoint since LOWTRAN requires a dewpoint to calculate the water vapor contribution to the Barnes IR transmission. Relative humidity can be defined in terms of total air pressure P (Fleagle and Businger, 1963),

$$RH = \left[\frac{e(P-e_s)}{e_s(P-e)} \right] \cdot 100, \qquad (1)$$

where e is the ambient vapor pressure and e_s is the saturation vapor pressure for air temperature T.

The Clausius-Clapeyron equation (equation 2.88, on Fleagle and Businger, 1963) relates the saturation vapor pressure e_s to temperature for an ideal gas and pure water,

$$\frac{de_s}{e_s} = \frac{L}{R_{mv}} \cdot \frac{dT}{T^2}, \qquad (2)$$

where L is the latent heat of vaporization and R_{mv} is the specific gas constant for water vapor. Integration of equation (2), considering the deviation from a perfect gas and experimental data, gives the Goff-Gratch formula for saturation vapor pressure (equation 1 on page 350 of the Smithsonian Meteorological Tables (List, 1971)). Murray (1967) gives a form of the Goff-Gratch equation more convenient for computation,

$$e_s = 7.95357242 \cdot 10^{10} \cdot \exp\,(X - Y + Z), \qquad (3)$$

where

$$X = 5.02808 \cdot \ln A - 18.1972839 \cdot A$$

$$Y = 70242.1852 \exp\,(-26.1205253/A)$$

$$Z = 58.0691913 \exp\,(-8.03945282 \cdot A)$$

$$A = \frac{373.16}{273.16 + T} .$$

Shettle (1978b) developed an analytic expression for relative humidity in terms of temperature and dewpoint by least squares fit for equation (1) for various combinations of T and T_D using equation (3) for vapor pressure and an atmospheric pressure of 1013mb,

$$RH = \left[\frac{19.772\,(T_D - T)}{269.9 + T + T_D} \right] \cdot 100. \qquad (4)$$

The conversion to dewpoint is:

$$T_D = \frac{19.772 \cdot T_D + \ln\left(\frac{RH}{100}\right) \cdot (269.9 + T)}{19.772 - \ln\left(\frac{RH}{100}\right)} . \quad (5)$$

These approximations have an RMS error of 0.11 percent for $-40 \leq T \leq 40°C$ and $0 \leq (T-T_D) \leq 40°C$, and a maximum error of 0.2 for $-35 \leq T \leq 35°C$.

The hair hygrometer used by Ypenburg can give biased results for high humidity measurements. Shields (1981) found that the highest values of aerosol IR extinction often occurred during periods of constant high relative humidities. Although the values changed for each episode of high aerosol IR extinction, they were all relatively close to 95 percent. The constant high humidity readings and high values of aerosol IR extinction suggest that the hygrometer was saturated and that the humidities were actually close to 100 percent. It should be noted that this problem only appeared in the preliminary release of the OPAQUE data from the Netherlands; the final version of their OPAQUE gives the corrected values of relative humidity.

The minimum detectable wind speed for both the 10 and 2 meter cup anemometer is 0.8 $msec^{-1}$. There is no effective way to distinguish between wind speeds of calm and 1 $msec^{-1}$. Therefore, all winds which are 1 $msec^{-1}$ and calm are grouped together for cumulative distributions. This combination is further justified since wind, for the most part, is never truly calm.

2.3 Electro-Optical OPAQUE Data.

2.3.1 Attenuation of Electromagnetic Propagation. The attenuation or extinction of radiation is given by the Lambert-Beer-Bouguer Law,

$$I\lambda = I_{\lambda o} \exp(-b_\lambda D) , \quad (6)$$

where I_λ is the intensity of the incident monochromatic radiation, b_λ is the monochromatic volume attenuation/extinction coefficient, D is the distance over which the extinction occurs, and $I_{\lambda o}$ is the intensity of the monochromatic transmitted radiation. The monochromatic transmittance is given by

$$\tau_\lambda = I_\lambda / I_{\lambda o} . \quad (7)$$

Both absorption and scattering by molecules and aerosols (wet and dry) contribute to the total monochromatic volume extinction,

$$b_\lambda = b_{ma,\lambda} + b_{ms,\lambda} + b_{aa,\lambda} + b_{as,\lambda} , \quad (8)$$

where ma is the molecular absorption contribution, ms is the molecular scattering contribution, aa is the aerosol absorption contribution, and as is the aerosol scattering contribution to the total extinction coefficient.

Scattering can be one of two types, depending on the radius of the scattering particle. Rayleigh scattering occurs where the radii of the scattering particles are smaller than about one-tenth the wavelength of the scattered radiation. Mie scattering covers all ratios of scattering particle diameters to wavelengths, but typically applies to cases where diameter-to-wavelength ratios are unity or larger (Huschke, 1959). Aerosol volume scattering predominates at shorter wavelengths while molecular absorption becomes more important as the wavelength increases. Table 3 shows the relative importance of each attenuating process for selected wavelengths.

TABLE 3. Significant Atmospheric Gaseous Absorbers (Water Vapor, H_2O; Carbon Dioxide, CO_2; Oxygen, O_2; and Ozone, O_3) at Visible and Infrared Wavelengths (after Cottrell et al., 1979).

WAVELENGTH INTERVAL (microns)	BAND	ABSORBER
1.319 - 1.498	1.38	H_2O
1.762 - 1.977	1.80	H_2O
2.520 - 2.845	2.70	H_2O
2.904 - 3.571	3.20	H_2O
4.100 - 4.45	4.30	CO_2
4.876 - 8.699	6.30	H_2O
9.400 - 9.9	9.60	O_3
10.591		CO_2
12.900 - 17.1	14.70	CO_2
18.000 - 20.0		H_2O

The size parameter χ can be used to define the type of scattering that will occur ,

$$\chi = \frac{2 \pi r}{\lambda} . \tag{9}$$

Rayleigh scattering occurs when χ is much less than one, while Mie scattering occurs when the size parameter is the order of one. Typically, aerosol particles such as dust, haze, and smoke have radii 10^{-3} to 10^{-4} cm, which yields a size parameter in the range of one to ten. Therefore, aerosol scattering is of the Mie type. Molecules in the atmosphere have a size range of 10^{-7} to 10^{-8} cm, which gives a size parameter χ of the order of 10^{-3}. Since this is considerably less than 1, molecular scattering is of the Raleigh type.

2.3.2 **Visual Transmittance.** The extinction b was measured by two methods: the percent transmission of radiation from a source to a detector (transmissometer) and from the amount of light scattered out of a light beam into a given angular cone (point visibility meter). For the OPAQUE project, extinction refers to the transmissometer measurements and scattering or attenuation to measurements from the point visibility meter. The effective path length for the Ypenburg transmissometer is 1000 m. The reported extinction values were converted to a 500m path length during data reduction to be compatible with the Barnes transmittance path length (see equation 12). Table 1 gives additional information on the two measurement procedures.

For the visual spectrum, or more specifically the photopic band in which the human eye is sensitive in daytime (.34 - .78 microns), molecular absorption is negligible (Cottrell et al., 1979). The primary source of extinction is from aerosol scattering. The EO/Met simulator uses the visual extinction since the Eltro transmissometer measurements are along the same baseline as the Barnes infrared transmission measurements.

2.3.3 **Infrared Transmittance.** The Barnes transmissometer measures transmittance over a 500m path length (along the same path as the Eltro transmissometer for visual extinction) for four spectral bands: 3.4-5.0 µm, 8-12 µm, 8.25-13.2 µm, and a narrow band around 4 µm. The bands have a minimum of molecular absorption. The transmissometer measures transmittance for the four spectral bands with a rotating filter wheel at the receiver. Fenn et al. (1979) give a description of and calibration procedures for the Barnes Transmissometer. The measurement period for the four measurements is 4 minutes at Ypenburg to 10 minutes at Christchurch. The filter changes position to a new spectral band once each minute. Since measurements for the two infrared spectral bands are from the same instrument, the observations are no longer independent of each other. The errors of observation from each measurement may now be correlated and can have a significant effect on cross correlations.

Figures 2 and 3 show the relative spectral response of the Barnes transmissometer receiver for the 3.4-5.0 and 8-12 micron filters (Janssen and van Sohle, respectively, 1981).

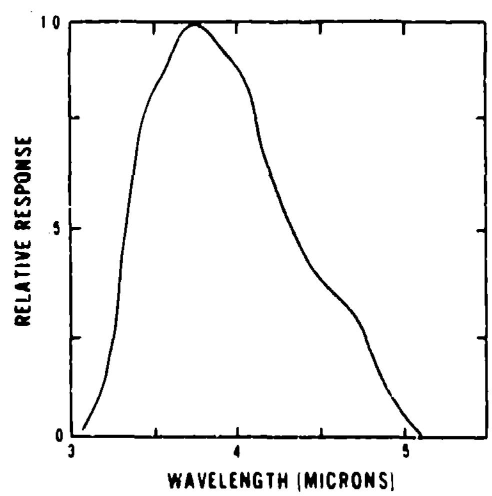

Figure 2. Relative Spectral Response of the Barnes Transmissometer Receiver for the 3.4--5.0 Micron Filter (after Janssen and van Sohle, 1981).

The 500m path length emphasizes high humidity and low visibility conditions. Table 3 shows the relative importance of absorption by water vapor (H_2O), carbon dioxide (CO_2), oxygen (O_2), and ozone (O_3) from 1 to 20 microns (Cottrell et al, 1979). Molecular absorption increases in importance as the wavelength of the radiation increases. Except for a few bands, molecular absorption is so strong that radiation undergoes substantial attenuation. For a few selected bands, transmission becomes a function of the concentration of the above molecules rather than the total attenuation that normally occurs. With the reduced molecular absorption, aerosol scattering and absorption can become important contributors.

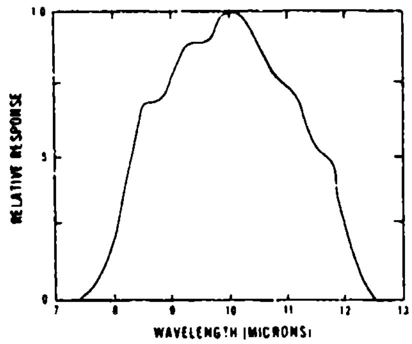

Figure 3. Relative Spectral Response of the Barnes Transmissometer Receiver for the 8.0--12.0 Micron Filter (after Janssen and van Schie, 1981).

2.4 Equivalent Aerosol Infrared Extinction.

2.4.1 Aerosol Transmission. Table 4 shows the relative importance of the four extinction processes over selected spectral intervals. For the visual spectral band (0.4 - 0.74 μm), scattering of radiation by aerosols is by far the largest contributor to extinction changes. Aerosol absorption can become important as wet haze changes into fog and mist. Molecular scattering by water vapor gives a small contribution for very high (≥ 95%) relative humidities. The entire reported extinction coefficient can therefore be treated as aerosol extinction coefficients.

TABLE 4. Relative Importance of Each Attenuating Process for Selected Wavelengths (after Cottrell et al., 1979).

WAVELENGTH REGION	IMPORTANT VOLUME ABSORPTION AND SCATTERING COEFFICIENTS (in order of importance)
0.40 - 0.74 μ	$^{m}b_{as,\lambda}$ $b_{ms,\lambda}$ $b_{aa,\lambda}$
0.74 - 2 μm	$b_{as,\lambda}$ $b_{aa,\lambda}$ $b_{ms,\lambda}$
3.00 - 5 μm	$b_{ma,\lambda}$ $b_{as,\lambda}$ $b_{aa,\lambda}$ $b_{ms,\lambda}$
8.00 - 12 μm	$b_{ma,\lambda}$ $b_{aa,\lambda}$ $b_{as\lambda}$.

Molecular absorption, aerosol absorption, and aerosol scattering all contribute to infrared extinction. Molecular scattering plays a relatively minor role in infrared extinction. Like the visual transmittance, aerosol size and concentration greatly influence changes in the infrared transmittance. Unlike the visual extinction, which is affected by the sub-micron region of the particle size distribution, infrared transmittance is mostly influenced by the larger aerosols. For a given aerosol size distribution during a haze event, visible light transmittance will be lower than infrared transmittance. However, in fog and mist where there is a larger number of droplets whose size is about equal to the wavelength, the infrared transmittance may be equal to or less than the visual transmittance. To allow a direct comparison with the visual aerosol extinction, the total IR transmission can be separated into the transmission due to aerosols, water vapor, and molecules.

2.4.2 Aerosol Extinction Coefficients. A more general form for the transmittance given in equation (7) is (Fleagle and Businger, 1965),

$$\tau_\lambda(R) = \frac{I_\lambda(x_o)}{I_{\lambda o}} , \tag{10}$$

where $I_\lambda(x_o)$ and $I_{\lambda o}$ are the radiances at path lengths x_o and 0 respectively and $\tau_\lambda(R)$ is the range dependent transmittance. Equation (10) is valid for monochromatic radiation only. The broadband sensors of the Barnes transmissometer produce an average weighted transmittance (Shettle, 1978a),

$$\bar{\tau} = \frac{\int_\lambda \tau_\lambda W_{\lambda,T} R_\lambda d_\lambda}{\int_\lambda W_{\lambda,T} R_\lambda d_\lambda}, \tag{11}$$

where $W_{\lambda,T}$ is the radiance of the source (A 650°C blackbody for the Barnes transmissometer) and R_λ is the spectral response of the sensor (figures 2 and 3). The equivalent extinction coefficient for broadband transmitted radiation is defined by:

$$\bar{\beta} = -\frac{\ln \bar{\tau}}{D}, \tag{12}$$

where $\bar{\beta}$ is the weighted average extinction and D is the path length.

The total transmittance can be represented as the product of the average transmittances for the various atmospheric constituents:

$$\bar{\tau} = \bar{\tau}_{aer} \cdot \bar{\tau}_{H_2O}(T,T_D) \cdot \bar{\tau}_{mol}(T), \tag{13}$$

where τ_{aer}, τ_{H_2O}, and τ_{mol} are the average transmittances for aerosols (both wet and dry), water vapor, and other molecular components and T, T_D are temperature and dewpoint respectively. Each transmittance can be calculated from an equation analogous to equation (11). Each transmittance includes both scattering and absorption, although a particular process may be relatively unimportant for specific spectral regions. Equation (13) is valid for monochromatic radiation only. Application to the infrared windows results in total transmittance errors that are usually less than one percent, which is better than the Barnes transmission measurement (Shettle,, 1978a).

2.4.3 An Aerosol Extinction Model. Following equation (13), the weighted average aerosol transmittance is:

$$\tau_{aer} = \frac{\tau_{meas}}{\tau_{H_2O}(T,T_D) \cdot \tau_{mol}(T)} \tag{14}$$

where τ_{meas} is the Barnes transmission observation. The calculations for τ_{H_2O} and τ_{mol} are based on the LOWTRAN 5 average broadband transmittances. Shettle (1978a) presents the partly theoretical, partly empirical, equations for water vapor and molecular transmittances,

$$\tau_{H_2O}(T_A T_D) = 1 - (C1 + C2) \cdot \exp[(D1 + D2 \cdot T) T_D], \tag{15}$$

$$\lambda_{m01}(T) = E + FT(16),$$

where equation (5) provides the dewpoint input. C1, C2, D1, D2, and F are fitted constants which depend on the transmissometer and the transmission range. Table 5 gives the fitted values for each OPAQUE location using a 500m path length.

TABLE 5. Constants for Molecular and Water Vapor Transmittance (after Shettle, 1978a).

CONSTANT	3.4 - 5.0 MICRONS YPENBURG	3.4 - 5.0 MICRONS CHRISTCHURCH	8 - 12 MICRONS YPENBURG	8 - 12 MICRONS CHRISTCHURCH
C1	6.536-2	4.844E-2	5.553E-2	6.734E-2
C2	-2.658E-4	-2.228E-4	-2.796E-4	-3.024E-4
D1	4.751E-2	5.127E-2	6.661E-2	6.075E-2
D2	-3.913E-4	-4.114E-4	2.044E-5	2.107E-5
E	0.8661	0.8629	0.9919	0.9857
F	1.40 E-4	1.32 E-4	3.8 E-5	4.0 E-5
AVERAGE ERROR	0.004	0.003	0.007	0.007
MAXIMUM ERROR	0.008	0.006	0.022	0.025

The wavelength dependence is slow enough for aerosols so that Beers Law (equation 6) holds for relatively wide spectral regions. The average weighted aerosol extinction for a .5 km path length follows from equation (12),

$$\bar{\beta}_{aer} = \frac{-\ln \tau_{aer}}{.5} . \qquad (17)$$

All measurements are subject to random error of observation (see Paragraph 5.3.1 for a complete discussion). Shields (1981) found that most of the measurement uncertainty from random error of observation was due to the two percent possible error in the total transmittance measurement. Shields gives an estimate for the aerosol infrared extinction error range as

$$\beta'_{aer} = \frac{-\ln\left[\exp\left(-.5(\beta_{aer} + \beta_{mol + H_2O})\right) \pm .02\right]}{.5} - (\beta_{mol} + H_2O) . \qquad (18)$$

Table 6 shows the aerosol extinctions resulting from a ± 2 percent change in the total transmittance. When the aerosol IR extinction is low, measurement uncertainty causes most of the variation. As the extinction values approach 1 km^{-1}, more of the changes in extinction can be attributed to other causes.

TABLE 6. Aerosol Extinction Uncertainty for ± 2% Uncertainty in Total Transmission (after Shields, 1981).

AEROSOL EXTINCTION τ	3-5 MICRONS τ + .02	3-5 MICRONS τ - .02	8-12 MICRONS τ + .02	8-12 MICRONS τ - .02
.01	-.04	.06	-.04	.06
.05	.00	.10	.00	.10
.10	.05	.15	.05	.15
.50	.43	.57	.44	.56
1.00	.92	1.09	.93	1.08
5.00	4.46	5.75	4.51	5.65
10.00	6.86	∞	7.05	∞

Error in relative humidity measurements, where the hair hygrometer has a five percent error, has only a small effect on low extinction values and does not significantly affect high extinctions (Shields, 1981). The molecular and water vapor extinctions are functions of temperature and relative humidity. An uncertainty of one percent in temperature gives an uncertainty of .007 km^{-1} and .014 km^{-1} in the final infrared aerosol extinctions for the 3.4-5.0 and 8-12 micron bands, respectively. An uncertainty of ten percent in relative humidity yields an uncertainty of .018 km^{-1} and .03 km^{-1} for the two bands.

CHAPTER 3

BASIC TECHNIQUES IN ENVIRONMENTAL SIMULATION

3.1 **General.** USAFETAC/TN-82/004, Basic Techniques in Environmental Simulation, contains a complete description of USAFETAC's capabilities in the environmental simulation arena. Because the development of the electro-optics/meteorology (EO/Met) simulator uses so many of these concepts, discussion of the basic simulation models has been condensed from USAFETAC/TN-82/004 and is included in this chapter. For a more detailed discussion of the statistical background, see USAFETAC/TN-82/004, Chapter 2. The EO/Met simulator uses the USAFETAC Multivariate Triangular Matrix (MULTRI) model to produce a simulated time series of an EO/Met variable or variables at a single location. Therefore, the discussion of the basic single variable, single station model and the MULTRI model are included in their entirety.

3.2 **Basic Concepts.**

3.2.1 **Probability Distributions, Densities, and Distribution Functions.** A random variable can be either discrete or continuous. The EO/Met variables within the OPAQUE data base can be treated as continuous real random variables over a defined, closed interval. Therefore, only continuous random variables will be discussed in association with the EO/Met variables. If X(S) is a random variable on a sample space S with a continuous image set, i.e., the image set X(S) is a continuum of numbers over the interval set $\{a \leq X \leq b\}$, the probability of the closed interval of X can therefore be represented as:

$$Pr\ (a \leq X \leq b) = Pr\ (\{s \in S:\ a \leq X(s) \leq b\}). \tag{19}$$

For a piecewise continuous function f_X, the probability $Pr\ (a \leq X \leq b)$ is equal to the area under the graph f_X between $x = a$ and $x = b$,

$$Pr\ (a \leq X \leq b) = \int_a^b f_X\ (x)dx\ , \tag{20}$$

where X is the random variable and x is a dummy variable. The function f_X is the probability density function (PDF) of X. The PDF f_X satisfies the conditions that (1) f is non-negative and (2) the total area under the graph is unity,

$$\int_R f_X\ (x)\ dx = 1\ . \tag{21}$$

The cumulative distribution function (CDF) F_X of the continuous random variable X is defined as the probability that X will take on some value less than or equal to a threshold value X,

$$F_X\ (x) = Pr\ (X < x) = \int_{-\infty}^{x} f(t)\ dx, \tag{22}$$

where t is a dummy variable. The CDF satisfies the conditions that:

(1) F_X (x) is monotonically increasing,

$$F_X(a) \leq F_X(b) \quad \text{for } a \leq b, \text{ and} \tag{23}$$

(2) the lower limit of F_X is zero,

$$\lim_{x \to -\infty} F_X(x) = 0, \text{ and} \tag{24}$$

(3) the upper limit of F_X is unity.

$$\lim_{x \to \infty} F_X(x) = 1. \tag{25}$$

The PDF f_X of a continuous random variable X is a derivation of the CDF F_X,

$$f_X(x) = dF_X/dx \geq 0. \tag{26}$$

Probability and cumulative probability are related by:

$$\begin{aligned} Pr\ (a \leq X \leq b) &= Pr\ (X \leq b) - Pr\ (X \leq a) \\ &= \int_{-\infty}^{b} f(t)tdt - \int_{-\infty}^{a} f(t)dt \\ &= F_X\ (b) - F_X\ (a)\ . \end{aligned} \tag{27}$$

The probability that a continuous random variable X takes on a single specified value d is zero,

$$Pr(X = d) = \int_d^d f(t) = F_X(d) - F_X\ (d) = 0. \tag{28}$$

For two events A and B that occur simultaneously, a joint probability of the joint event can be described as Pr (A B). Let X and Y be continuous random variables whose joint PDF is f_{XY} and CDF is F_{XY} (x,y). The two are related by:

$$f_{XY}\ (x,\ y) = \frac{\partial^2}{\partial x \partial y} F_{XY}(x,y) \tag{29}$$

and the joint CDF is

$$F_{XY}\ (x,y) = Pr\ (X \leq x \text{ and } Y \leq y) = \int_{-\infty}^{x}\int_{-\infty}^{y} f_{XY}(s,t)\ ds\ dt\,. \tag{30}$$

If only the behavior of one of the variables, say X, is required, then the PDF of X can be found by integrating the joint PDF over all values of Y:

$$f_x = \int_{-\infty}^{\infty} f_{XY}\ (x,s)\ ds. \tag{31}$$

The probability distribution of one variable, regardless of the value of the other variables is the marginal probability distribution. The cumulative marginal distribution becomes:

$$\begin{aligned} F_X\ (x) &= F_{XY}\ (x,\infty) = Pr\ (X \leq x \text{ and } Y \leq \infty) \\ &= Pr\ (X \leq x) \\ &= \int_{-\infty}^{x} \int_{-\infty}^{\infty} f_{XY}\ (s,t)\ ds\ dt \\ &= \int_{-\infty}^{x} f_X\ (s)\ ds. \end{aligned} \tag{32}$$

3.2.2 Stochastic and Markov Processes. The stochastic, or random, process is the heart of environmental simulation modeling. The process is a succession of values taken on by a random variable X(t) as a function of the parameter t. The parameter t is drawn from the set T, called the index set of the process. Random processes are controlled by probabilistic laws. In many applications, the index parameter t of the stochastic process represents time but can also be used as some sort of event sequence number. A time series is a finite realization of a stochastic process where the index parameter t represents time. A time series can be produced either in the form of output from a model or in the form

of experimental data. A time series, in other words, is a sequence of values of a random variable collected over discrete or continuous time.

In a stochastic process model, a random variable q_t can be formed as the sum:

$$q_t = d_t + \epsilon_t \tag{33}$$

of a deterministic part d_t and a random or stochastic part ϵ_t. Typically, the deterministic part contains the contribution of preceding values q_{t-1}, q_{t-2}, etc., in the series but may also have terms such as $\bar{q}$ representing the mean value or $\tilde{q}$ representing a secular or long-term trend in values. The random part ϵ_t of the solution introduces noise or uncertainty into the process being modeled; otherwise, the process would not be random at all. As shown in equation (33), there is no restriction on the form of ϵ_t, but in practice it tends to be either (1) a number drawn at random from a population distributed uniformly over the interval [0,1] with mean of 1/2 and variance of 1/12, or (2) a number drawn at random from a population distributed normally over the interval $(-\infty, \infty)$ with mean of zero and variance of 1; i.e., N(0,1). That is to say, ϵ_t is either a uniform random number or a normal random number.

If the stochastic process shown in equation (33) above is further assumed to be covariance-stationary, then neither the mean(s) nor the variance(s) of the quantity(ies) being simulated are dependent on the index parameter t (i.e., they do not change with time if t represents time), and the covariance between two successive values, q_t and $q_{t+\Delta t}$; i.e., $Cov(q_t, q_{t+\Delta t})$ becomes a function only of the separation Δt between the two, and does not depend on the absolute values of the index parameter t. Also, the correlation ρ between successive values of q becomes dependent only on the separation Δt; i.e.,

$$\rho_{t,t+\Delta t} = \rho_{\Delta t} = \frac{Cov(q_t, q_{t+\Delta t})}{\sqrt{\sigma_t^2 \; \sigma_{t+\Delta t}^2}} = \frac{Cov(q_o, q_{\Delta t})}{\sigma^2} \tag{34}$$

(because $\sigma_t^2 = \sigma^2 = \sigma_{t+\Delta t}^2$).

Applying the covariance-stationary assumption to the process of equation (33) leads to the linear autoregressive (AR) relation,

$$q_t = \beta_o + \beta_1 q_{t-1} + \beta_2 q_{t-2} + \dots + \beta_m q_{t-m} + \epsilon_t , \tag{35}$$

where the β_i are the autoregression coefficients, and the ϵ_t is an independent error term. In this formulation, the deterministic part of the solution depends on the lag-one value q_{t+1}, the lag-two value q_{t-2}, etc., and the random part of the solution is now an independent error term with mean of zero.

The AR process (equation 35) can be further restricted by applying the first-order Markovian assumption that the value q_t of the process at t depends only on the previous value q_{t-1}. Then the model becomes:

$$q_t = \beta_o + \beta_1 q_{t-1} + \epsilon_t , \tag{36}$$

an autoregressive (AR), first order Markov model. For such models, the serial correlation ρ (the correlation in the t-dimension) follows an exponential decay law (see Appendix A):

$$\rho_{\Delta t} = \rho_1^{\Delta t} , \tag{37}$$

where ρ_1 is the serial correlation for lag $\Delta t = 1$. Equation (37) shows that for a Markov model, realizations spaced Δt units apart will have correlation

$$\rho^{\Delta t}.$$

In order to estimate the parameters β_0 and β_1 and to specify the form of the error term ε_t, q_t and q_{t-1} that are assumed to be derived jointly from a bivariate normal population with means:

$$\mu_t = \mu_{t-1} = \mu \tag{38}$$

and variances:

$$\sigma_t^2 = \sigma_{t-1}^2 = \sigma^2. \tag{39}$$

This causes the regression function of q_t on q_{t-1} to be linear and homoscedastic (of constant variance). The conditional expectation of q_t given q_{t-1} is:

$$E(q_t | q_{t-1}) = \mu + \rho(q_{t-1} - \mu) , \tag{40}$$

where ρ is the correlation between q_t and q_{t-1} and the variance is:

$$\mathrm{Var}(q_t | q_{t-1}) = \sigma^2(1 - \rho^2), \tag{41}$$

which is independent of q_{t-1}.

As shown in almost any elementary statistics text, the standard normal variable (equivalent normal deviate) z_w corresponding to the normally distributed raw variable w with mean (expected value) μ_w and standard deviation σ_w is

$$z_w = \frac{w - \mu_w}{\sigma_w} . \tag{42}$$

Therefore, the value of the raw variable w can be calculated from

$$w = \mu_w + \sigma_w z_w . \tag{43}$$

Using $q_t | q_{t-1}$ for w in equation (43), and substituting from equation (40) for μ_w and equation (41) for σ_w yields

$$q_t = \mu + \rho\ (q_{t-1} - \mu) + \sigma \sqrt{1-\rho^2}\ z_q , \tag{44}$$

where z_q is a random normal number. Comparing equation (44) with (36) shows that:

$$\beta_o = \mu(1 - \rho) \text{ and } \beta_1 = \rho \tag{45}$$

$$\varepsilon_t = \sigma \sqrt{1 - \rho^2}\ z_q . \tag{46}$$

Equation (44) can be rearranged and transformed into mean-deviation form using:

$$v_{(\cdot)} = q_{(\cdot)} - \mu_{(\cdot)} , \tag{47}$$

with the result:

$$v_t = \rho v_{t-1} + \sigma \sqrt{1 - \rho^2}\ \eta \tag{48}$$

where η, like z_q, is simply a random normal number.

Equations (33), (35), and (36), (44), and (48) present a spectrum of increasingly more specific and more restrictive stochastic process models. Equation (33) is a very general form that can be used to describe almost any stochastic process model. Equation (35) represents a covariance-stationary, linear autoregressive (AR) process. Finally, equations (36), (44), and (48) further require the first-order Markov assumption be made and normally distributed according to the bivariate normal probability distribution.

Equation (48) is the Ornstein-Uhlenbeck stochastic process model that forms the basis for much of the present work in environmental simulation modeling. It is a first-order Markov process in which the probability that a physical system will be in state x_1 at time t_1 may be deduced strictly from knowledge of the system's state x_0 at time t_0 and does not depend on the history of the system before t_0.

When applying Markov models to data, one must estimate the order of the Markov model that best fits the data. Whiton and Berecek (1982) show that wind speed, which roughly has an exponential decay of autocorrelation r_k as a function of lag k, complies with the restrictions of the AR(1) first order Markov model. It is a common and usually justifiable assumption to treat other weather variables as a first-order Markov process. Since the electro-optical variables are a function of the meteorological variables, it is also equally justifiable to treat them as a first-order Markov process.

3.3 **Single-variable,Single-station Model (V1S1).** USAFETAC's basic environmental simulation model is an Ornstein-Uhlenbeck stochastic process. This single-variable model is an autoregressive (AR), first-order Markov process in which each value of a random variable X_t is taken to be a particular value of a stationary stochastic process. The Ornstein-Uhlenbeck process is well based in the statistical literature and can be applied with substantial justification to variables whose time series have a random component and approximately adhere to the first-order Markov restriction.

The generation of a time series of a single meteorological variable would be quite simple if each value in the time sequence were independent of all others in the sequence. In general, this is not the case. Whether successive meteorological observations are independent depends on the time separation between them. The common separation between surface meteorological observations is 1, 3, or 6 hours. At these separations, successive observations of most meteorological variables are not serially independent. A goal of a simulation model should therefore be to reproduce this serial dependence between successive values of the particular meteorological variable being simulated, as well as to reproduce its probability distribution.

Assume that the variable to be simulated is normally distributed. If the variate is not normally distributed, then it can be transformed to the normal distribution by expressing the values of the raw variable in terms of its equivalent normal deviate (END). (Transformation of variables to the normal distribution is covered in detail in Boehm (1976) and is summarized in Section 3.4). The joint normal density function of two weather variables X_t and X_{t+1} at times t and t+1 with mean μ, variance σ^2, and serial correlation ρ between successive values is

$$f_{X_t X_{t+1}}(x_t, x_{t+1}) =$$

$$\frac{1}{2\pi\sigma^2(1-\rho^2)^{1/2}} \exp\left[\frac{(x_t-\mu)^2-2\rho(x_t-\mu)(x_{t+1}-\mu)+(x_{t+1}-\mu)^2}{2\sigma^2(1-\rho^2)}\right]. \quad (49)$$

The joint normal probability of two random variables with the same mean and variance depends only on μ, σ^2, and their correlation ρ. The generation of a time series of observations then requires the conditional distribution of the weather variable at one time given the value of the variable in previous hours. If the weather process approximates a first-order Markov process, then the value of the variable at time t summarizes the dependence of the distribution of the variable for all previous hours. If successive observations of this arbitary weather variable have a multivariate normal distribution, then the conditional distribution of X_{t+1} is normal with mean and variance equal to

$$E[X_{t+1} | X_t = x_t] = \mu + \rho(x_t - \mu) \quad (50)$$

$$Var[X_{t+1} | X_t = x_t] = \sigma^2(1 - \rho^2), \quad (51)$$

where x_t is the value of X_t at hour t. From equation (51), the larger the absolute value of the serial correlation ρ between the values of the variable, the smaller the conditional variance of X_{t+1}, which does not depend at all on the value of x_t.

A time series of synthetic, normally distributed variables with mean μ, variance σ^2, and serial correlation ρ is produced by the equation,

$$X_{t+1} = \mu + \rho(X_t - \mu) + \sigma\sqrt{1-\rho^2}\; n_t \,, \tag{52}$$

when n_t is a standard normal random number, i.e., a number drawn at random from a population with a mean of zero and a variance of unity, abbreviated as N(0,1). Each n_t is totally independent of past values of n as well as past values of X. If the variable being simulated is expressed as an END (which itself is distributed N(0,1)), then equation (52) simplifies to:

$$X_{t+1} = \underset{(a)}{\rho X_t} + \underset{(b)}{\sqrt{1-\rho^2}\; n_t} \,, \tag{53}$$

which is an Ornstein-Uhlenbeck stochastic process in two parts, a deterministic part (a) and a random or stochastic part (b) expressing the uncertainty in the random process. X_{t+1} will have a normal distribution if both X_t and n_t are normally distributed because the central limit theorem states the sums of independent, normally distributed random variables are normally distributed.

In the case of independence between successive X values ($\rho = 0$), the deterministic part (a) is 0 and the stochastic part (b) is 1, so successive values of X are fully random. In the case of complete positive dependence between successive values of X ($\rho = 1$), the deterministic part is fully in control, and each succeeding value of X is identical to the previous value of X.

Whiton and Berecek show that the model defined by equation (52) reproduces distributions with the correct conditional mean and variance defined by equations (50) and (51). The conditional mean of X_{t+1} does not depend on the assumption that the random variables X_t and n_t are normally distributed. This relationship applies to all autoregressive Markov processes in the form of equation (52), regardless of the distributions of X_t and n_t. However, if the variable X_t at time t is normally distributed with mean μ and variance σ^2 and if the n_t values are independently normally distributed with a mean of 0 and variance of 1, then the generated X's for $t \geq 1$ will also be normally distributed with mean μ and variance σ^2.

3.4 **Transformation to the Normal Distribution.** In order to apply equation (53) to a weather variable that is not normally distributed, one must first transform the non-normal variable to its equivalent normal deviate (END) e. The transformation to the normal distribution is referred to as transnormalization. The probability density function of the standard normal distribution is given by

$$\phi(u) = \frac{1}{\sqrt{2\pi}} \exp(-u^2/2). \tag{54}$$

The cumulative probability that the random variable X is less than some threshold x_T, whose END is E, is the integral of the standard normal density function from $-\infty$ to E ,

$$\Phi(x_T) = Pr\left\{X \leq x_t\right\} = \int_{-\infty}^{E} \phi(u)\, du. \tag{55}$$

The probability $Pr(X \leq x_T)$ is thus actually the area under the standard normal curve from $-\infty$ to E. Figure 4 shows the shaded area for an integration of the normal probability distribution from $-\infty$ to E, which yields a cumulative probability of 0.351. This integral cannot be determined analytically. In practice, one uses a polynomial approximation to the integral of the standard normal distribution. Although tables of integrals of the normal probability distribution can be used, rational approximation works better on a computer.

Figure 5 depicts the empirically determined cumulative frequency distribution $Pr(V \leq v_T)$ of the visual extinction at Ypenburg for October at 0400 MST, where V represents the extinction per km and v_T is some threshold value of the extinction. For an extinction of $v_T = .45\ km^{-1}$ the probability that $Pr(V \leq v_T)$ is 0.351. A probability of 0.351 corresponds to an END of 0.381. Because the observations of extinction are limited in number, it is better to say that a .45 km^{-1} extinction corresponds to an END of -0.351. Table 7 gives sample values of visual extinction and the corresponding values of cumulative probabilities and ENDs.

TABLE 7. Transnormalization from Visual Extinction to an END for Ypenburg, NL, at 0400 MST, October.

Visual Extinction	Cumulative Probability	END
.10	0.05	-1.645
.20	0.16	-0.994
.30	0.25	-0.674
.51	0.39	-0.279
.75	0.50	0.000
1.01	0.59	0.227
2.50	0.82	0.915

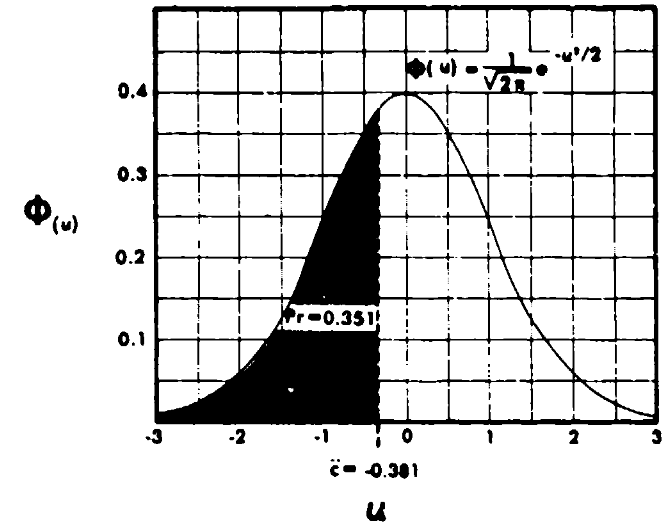

Figure 4. Normal Probability Distribution Integrated from $-\infty$ to E, Yields a Cumulative Probability of 0.351.

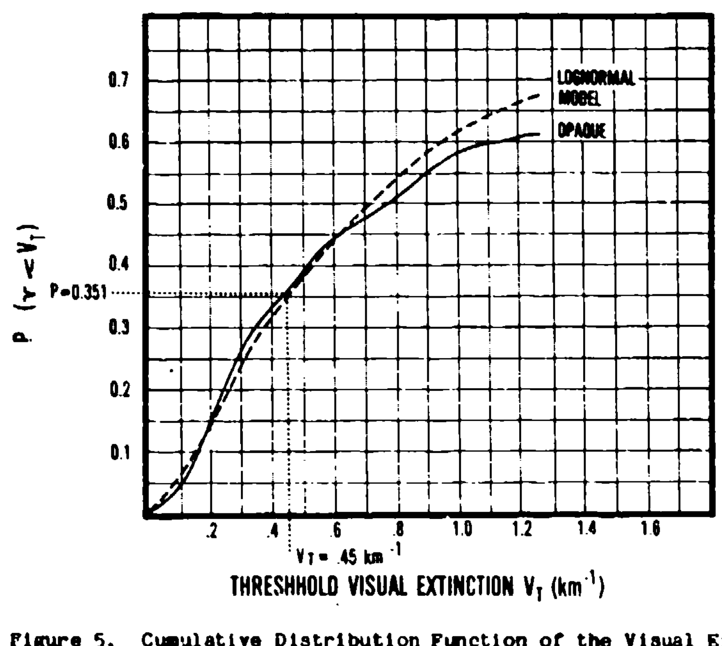

Figure 5. Cumulative Distribution Function of the Visual Extinction at Ypenburg for October at 0400 MST. The CDF is from the OPAQUE data and the modeled distribution is the Johnson single-bounded (lognormal).

Using the normal transformation, every extinction corresponds to an END of that extinction. Since ENDs are in themselves normally distributed with a mean of zero and variance of one, they can be used as random variables in the Ornstein-Uhlenbeck process represented by equation (53). Such a process for extinction (not normally distributed in general) is

$$\ddot{v}_{t+1} = \rho_{vv}\, \ddot{v}_t + \sqrt{1 - \rho_{vv}^{\;2}}\; n_t \,, \tag{56}$$

where $\ddot{v}$ values are ENDs of the visual extinction.

To see how such a simulation might work in practice, consider a case with an initial visual extinction of .51 km^{-1} (which corresponds to a meteorological visual range of 7.67 km using Koschmieder's constant of 3.912). The corresponding END is -0.279. Assume a correlation according to Gringorten's model,

$$\rho_{vv} = 0.945^{\Delta t} \tag{57}$$

where Δt is the time step (unity in this case). Applying the Ornstein-Uhlenbeck process in equation (53) using a generated random normal number n_t = 0.325 yields:

$$\ddot{v}_{t+1} = (0.945)\ (-0.279) + (\sqrt{1 - 0.945^2})\ (0.325)$$

$$= (0.945)\ (-0.279) + (0.327)\ (0.325)$$

$$= -0.263 + 0.106$$

$$= -\ 0.157\ ,$$

which corresponds to a visual extinction of about .601 km^{-1}. At the next time step, $\ddot{v}_t$ becomes -0.157. Another random normal number is drawn, say -0.102. Then:

$$\ddot{v}_{t+1} = (0.945)\ (-0.157) + (0.327)\ (-0.102)$$

$$= -0.148 + 0.033$$

$$= -0.115\ ,$$

which corresponds to a visual extinction of about .688 km^{-1}.

If continued, this process will generate a time series of the visual extinction whose probability distribution is the same as the distribution specified initially within the limits imposed by sampling error. The process will not necessarily produce the same durations as those of the original data. The distribution of durations of low visibility episodes is affected by the parameter ρ_{vv} and by the first-order Markov assumption. It is possible to determine a value of ρ_{vv} that will best "fit" a given distribution of durations.

3.5 **Two-variable, Single-station Model (V2S1).** The simulation model expressed in equation (53) is severely limited, in the sense that it can be applied only to a time series of a single variable. One is frequently interested in simulating more than one variable in such a manner as to preserve the cross-correlation between them. The V2S1 model handles the two variable case by including two time series of ENDs, one END for each of the two variables, and then carrying the cross-correlation information in the stochastic part of the solution. For example, for ENDs $\ddot{c}$ and $\ddot{v}$ for relative humidity and visual extinction, respectively, the time series advance by separate Ornstein-Uhlenbeck equations desired by the V1S1 model,

$$\ddot{c}_{t+1} = \rho_{cc}\, \ddot{c}_t + \sqrt{1 - \rho_{cc}^{\,2}}\; \eta_c \qquad (58)$$

$$\ddot{v}_{t+1} = \rho_{vv}\, \ddot{v}_t + \sqrt{1 - \rho_{vv}^{\,2}}\; \eta_v \;. \qquad (59)$$

To produce time series of humidity and extinction that are correlated across variables (i.e., cross-correlated), the stochastic parts of equations (58) and (59) must be linked. This is done by generating a random normal number of extinction η_v that is correlated with that, η_c, previously generated for humidity. To do this, the procedure is first to generate an independent η_c and then to set

$$\eta_v = \rho'_{cv}\, \eta_c + \sqrt{1 - \rho'^{\,2}_{cv}}\; \eta \;, \qquad (60)$$

where η is another independent random normal number and ρ'_{cv} is proportional to the cross-correlation between ENDs of humidity and extinction. Equation (60) is the generation algorithm for producing ENDs having the correlation ρ_{cv}.

In the case of independence when $\rho'_{cv} = 0$, $\eta_v = \eta$ and equations (58) and (59) generate unrelated time series of humidity and extinction. In the case of perfect positive correlation, when $\rho_{cv} = 1$,

$$\eta_v = \eta_c \;,$$

the time series for extinction will depend completely on that for the humidity. If ρ_{cc} and ρ_{vv} both are one, the two time series will be identical except for a shift due to differing initial values. In the intermediate case, extinction and humidity will be partially correlated according to the value of ρ'_{cv}, which is proportional to the correlation ρ_{cv} between humidity and extinction. The process is depicted in Figure 6.

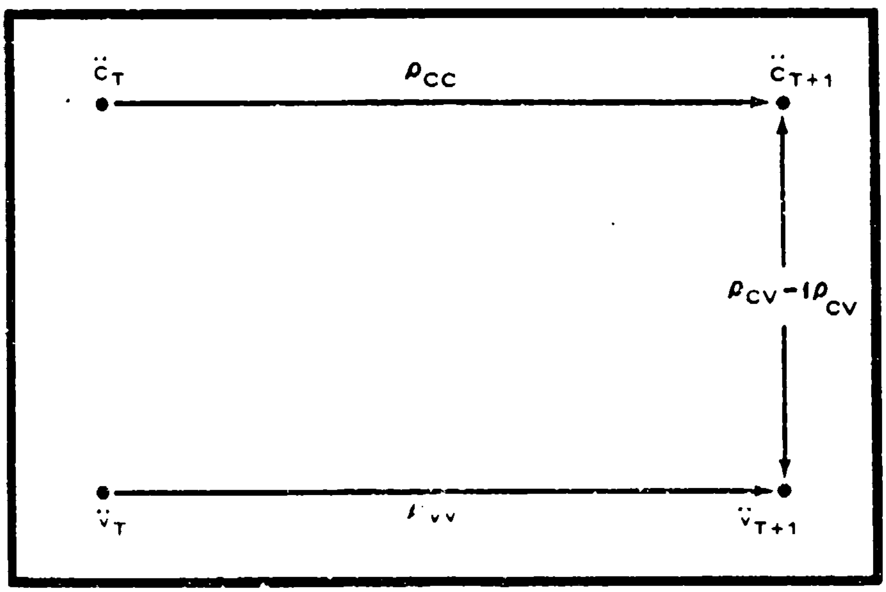

Figure 6. The O-U Simulation Process for the Two Variable Case.

The serial correlation ρ_{cc} between humidity at t and humidity at t+1 is preserved, as is the correlation ρ_{vv} between extinction at time t and extinction at time t+1. The correlation ρ_{cv} between humidity and extinction at the same time is proportional to ρ'_{cv} through a constant of proportional f. Whiton and Berecek (1982) show this constant of proportionality to be:

$$\rho'_{cv} = \frac{1 - \rho_{cc}\,\rho_{vv}}{\sqrt{1-\rho_{cc}^2}\;\sqrt{1-\rho_{vv}^2}}\,\rho_{cv} = f\rho_{cv} \quad . \tag{61}$$

The factor f reduces to 1 when $\rho_{cc} = \rho_{vv}$ but otherwise is greater than 1, so

$$\rho'_{cv} \geq \rho_{cv} \, .$$

From equation (60), the real solutions can be obtained only if ρ'_{cv} is less or equal to unity. Hence:

$$f\,\rho_{cv} \leq 1 \text{ , and } \rho_{cv} \leq \frac{1}{f} \, .$$

Thus, the mathematics impose an upper limit on the cross-correlation this model is capable of producing between the two variables. For example, if $\rho_{cc} = 0.8$, $\rho_{cv} = 0.4$, and $f = 1.24$, then ρ_{cv} cannot exceed 0.81. In this case, the model in its present form cannot simulate "c" and "v" whose ENDs are cross-correlated more strongly than 0.81. This upper limit on ρ_{cv} depends on ρ_{cc} and ρ_{vv} and must be treated on a case-by-case basis. In the special case where $\rho_{cv} = \rho_{cv}$, cross correlation values up to 1.0 can be simulated.

The V2S1 model does not explicitly preserve what is known as the cross-lag correlation, such as $\rho v_t c_{t+1}$, the correlation between the extinction at time t and the humidity at time t+1. Whiton and Berecek show that the cross-lag correlation reduces to the product of autocorrelation of the first variable and the cross correlation between the two variable,

$$\rho_{c_{t+1}v_t} = \rho_{cc}\rho_{cv} \, . \tag{62}$$

This is equivalent to saying that, for the V2S1 model, the cross-lag correlation reduces to the automatic correlation between the two variables. Figure 7 shows the applications to the V2S1 model.

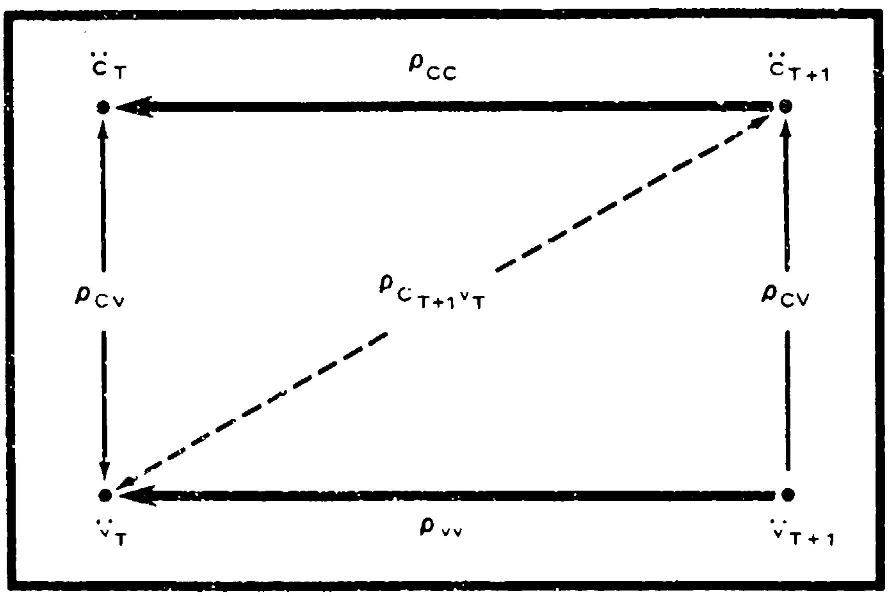

Figure 7. Correlation Influence Diagram for the Two-Variable O-U Model. The cross-lag correlation is shown as a dotted line because it reduces it to automatic correlation in this model.

Whether this is true in nature is another question. A model is a simplification or generalization of nature. Work conducted to date gives no indication that reducing the cross-lag correlation to the automatic correlation has any adverse affect on the model as a weather simulator. Whiton and Berecek (1981) believe that cross-lag correlations between ceiling and visibility are very equal to automatic correlation. Whether this is true or at least approximately true for other variables is subject to verification using actual data.

3.6 The Multivariate Triangular Matrix Model.

3.6.1 General. Although the V1S1 and V2S1 models are excellent for time series of one or two variables, few simulations are limited only to two variables. The Multivariate Triangular Matrix (MULTRI) model is capable of generating an independent vector of N correlated elements. These elements can represent several variables at a single station or a single variable for different time steps. Whiton and Berecek (1982) show the MULTRI model for two variables reduces to the V2S1 Orstein-Uhlenbeck model. The MULTRI simulation model allows more flexibility than the V1S1 and V2S1 models.

3.6.2 The Variance-Covariance Matrix. Let $\underline{X}$ be a vector stochastic variable consisting of $j = 1, 2, 3, \ldots, M$ scalar variables X_j and $k = 1, 2, 3, \ldots, N$ observations $\underline{X}_k$ such that:

$$
X_{jk}] = \begin{array}{cc} j \rightarrow & \\ \left|\begin{array}{cccc} X_{11} & X_{12} & \cdots & X_{1M} \\ X_{21} & X_{22} & \cdots & X_{2M} \\ \cdots & \cdots & \cdots & \cdots \\ X_{N1} & X_{N2} & \cdots & X_{NM} \end{array}\right| & \begin{array}{c} k \\ \downarrow \end{array} \end{array} . \tag{63}
$$

The kth observation of $\underline{X}$ is the row vector:

$$\underline{X}_k = [X_{1k}\ X_{2k}\ \cdots\ X_{Mk}]. \tag{64}$$

The random variable $\underline{X}$ can be expressed in terms of its deviation from the mean $\underline{X}$ by

$$\underline{x} = \underline{X} - \bar{\underline{X}} . \tag{65}$$

The sum of the squares and cross products (SSCP) in raw-score form is the symmetric matrix $\underline{X}'\underline{X}$:

$$
\underline{X}'\underline{X} = \left|\begin{array}{cccc} \Sigma X_1^2 & \Sigma X_1X_2 & \cdots & \Sigma X_1X_M \\ \Sigma X_2X_1 & \Sigma X_2^2 & \cdots & \Sigma X_2X_M \\ \cdots & \cdots & \cdots & \cdots \\ \Sigma X_MX_1 & \Sigma X_MX_2 & \cdots & \Sigma X_M^2 \end{array}\right| . \tag{66}
$$

Similarly, the deviation-score SSCP is

$$
\underline{x}'\underline{x} = \left|\begin{array}{cccc} \Sigma x_1^2 & \Sigma x_1x_2 & \cdots & \Sigma x_1x_M \\ \Sigma x_2x_1 & \Sigma x_2^2 & \cdots & \Sigma x_2x_M \\ \cdots & \cdots & \cdots & \cdots \\ \Sigma x_Mx_1 & \Sigma x_Mx_2 & \cdots & \Sigma x_M^2 \end{array}\right| . \tag{67}
$$

The two are related:

$$\underline{x}'\underline{x} = \underline{X}'\underline{X} - \bar{\underline{X}}'\bar{\underline{X}} , \tag{68}$$

which gives the computational rule for obtaining $\underline{x}'\underline{x}$.

An unbiased estimate of the dispersion or variance-covariance matrix $\underline{D}$ is given by dividing the elements of the deviation-score SSCP by the number of degrees of freedom, i.e., N - 1.

$$D = \frac{1}{N-1} \sum_{k=1}^{N} \underline{x}'_k \underline{x}_k \quad , \tag{69}$$

or

$$D_{ij} = \frac{1}{N-1} \sum_{k=1}^{N} x_{ik} x_{jk}$$

where k is a datum index varying from k = 1 for the first vector x to k = N for the final vector. Note that $\underline{D}$ is a symmetric (M x M)-dimensional matrix. The maximum likelihood estimate of $\underline{D}$ is given by:

$$\underline{D} = E(\underline{x}'\underline{x}) = \frac{1}{N} \sum_{K=1}^{N} \underline{x}'_k \underline{x}_k \tag{70}$$

or:

$$D_{ij} = \frac{1}{N} \sum_{k=1}^{N} x_{ik} x_{jk} \quad . \tag{71}$$

The maximum likelihood estimate is used in this and similar contexts because as long as N' data are independent out of N total data, the variance-covariance matrix will be positive definite. Such a matrix is, in theory, invertible. The maximum likelihood estimate is biased; variance-covariance estimates will be smaller, on the average, than they should be. The bias is not a problem in this application.

The variance of a variable X is:

$$\sigma_X^2 = E[\ (X - \mu_X)^2\ ] = E[\ (X - \mu_X)(X - \mu_X)\ ] = \frac{1}{N} \sum_{k=1}^{N} (X_k - \mu_X)\ (X_k - \mu_X). \tag{72}$$

The covariance between two variables X and Y is:

$$\sigma_{XY} = E[\ (X - \mu_X)(Y - \mu_Y)\ ] = \frac{1}{N} \sum_{k=1}^{N} (X_k - \mu_X)(Y_k - \mu_Y)\ . \tag{73}$$

The linear correlation ρ_{XY} between X and Y is simply the covariance between X and Y divided by the product of the standard deviations of X and Y; i.e.,

$$\rho_{XY} = \frac{\sigma_{XY}}{\sigma_X\ \sigma_Y}$$

or:

$$\rho_{XY} = E[\ \frac{(X - \mu_X)}{\sigma_X}\ \frac{(Y - \mu_Y)}{\sigma_Y}\ ]\ . \tag{74}$$

Note that the covariance of X with X reduces to the variance X; i.e.,

$$\sigma_{XX} = E[\ (X - \mu_X)\ (X - \mu_X)\ ] = E[\ (X - \mu_X)^2\ ] = \sigma_X^2\ . \tag{75}$$

The covariance between a variable X_1 and a variable X_2 is:

$$\sigma_{12} = \frac{1}{N} \sum_{k=1}^{N} (X_1 - \overline{X}_1)\ (X_2 - \overline{X}_2) = \frac{1}{N} \sum_{k=1}^{N} X_1 X_2 \tag{76}$$

and between X_1 and X_3 is:

$$\sigma_{13} = \frac{1}{N} \sum_{k=1}^{N} X_1 X_3 \tag{77}$$

Thus, the variance-covariance matrix $\underline{D}$ can be written as:

$$\underline{D} = \begin{vmatrix} \sigma_{11} & \sigma_{12} & \cdots & \sigma_{1M} \\ \sigma_{21} & \sigma_{22} & \cdots & \sigma_{2M} \\ \cdots & \cdots & \cdots & \cdots \\ \sigma_{M1} & \sigma_{M2} & \cdots & \sigma_{MM} \end{vmatrix} \tag{78}$$

or:

$$\underline{D} = \begin{vmatrix} \sigma_1^2 & \sigma_{12} & \cdots & \sigma_{1M} \\ \sigma_{21} & \sigma_2 & \cdots & \sigma_{2M} \\ \cdots & \cdots & \cdots & \cdots^2 \\ \sigma_{M1} & \sigma_{M2} & \cdots & \sigma_M \end{vmatrix} . \tag{79}$$

Because

$$\sigma_{XY} = \sigma_X \sigma_Y \rho_{XY} , \tag{80}$$

the variance-covariance matrix can be written as:

$$\underline{D} = \begin{vmatrix} \sigma_1^2 & \sigma_1 \sigma_2 \rho_{12} & \cdots & \sigma_1 \sigma_M \rho_{1M} \\ \sigma_2 \sigma_1 \rho_{21} & \sigma_2 & \cdots & \sigma_2 \sigma_M \rho_{2M} \\ \cdots & \cdots & \cdots & \cdots^2 \\ \sigma_M \sigma_1 \rho_{M2} & \sigma_M \sigma_2 \rho_{M2} & \cdots & \sigma_M \end{vmatrix} . \tag{81}$$

The form of the variance-covariance matrix $\underline{D}$ is such that the sample variances σ_i^2 are along the main diagonal and the sample covariance σ_{ij}, $i \neq j$ are the off-diagonal elements.

In the special case of a random variable $\underline{X}$ distributed normally with a mean of zero and a variance of one; i.e., N(0,1),

$$\bar{\underline{X}} = \underline{0} \tag{82}$$

$$\underline{x} = \underline{X} \tag{83}$$

$$\underline{x}'\underline{x} = \underline{X}'\underline{X} \tag{84}$$

and:

$$\underline{D} = \underline{R} , \tag{85}$$

where $\underline{R}$ is the correlation matrix, given by:

$$\underline{R} = \begin{vmatrix} 1 & \rho_{12} & \cdots & \rho_{1M} \\ \rho_{21} & 1 & \cdots & \rho_{2M} \\ \cdots & \cdots & \cdots & \cdots \\ \rho_{M1} & \rho_{M2} & \cdots & 1 \end{vmatrix} , \tag{86}$$

which is symmetric.

If the vector stochastic variable $\underline{X}$ has the multivariate normal probability distribution, then the probability density function of $\underline{X}$ is:

$$f(\underline{X}) = \frac{1}{\sqrt{|2\pi \underline{D}|}} \exp[- \frac{1}{2} (\underline{X} - \mu_X)' \underline{D}^{-1} (\underline{X} - \mu_X)] , \tag{87}$$

where $|\ |$ represents the determinant and $\underline{D}^{-1}$ is the inverse of the variance-covariance matrix $\underline{D}$.

3.6.3 The Lower Triangular Matrix. Random multivariate normal vectors $\underline{X}$ with a mean vector $\underline{\mu}_X$ and variance-covariance matrix $\underline{D}$ can be generated by using a theorem (as shown in Whiton and Berecek, 1982) which states that if $\underline{\eta}$ is a standard normal vector containing independent normal variable components η_i each distributed N(0,1), then there exists a unique lower triangular matrix $\underline{C}$ such that

$$\underline{X} = \underline{C}\,\underline{\eta} + \underline{\mu}_X \ , \tag{88}$$

where $\underline{C}$ is an (M x M) matrix and $\underline{X}$ and $\underline{\mu}_X$ are (M x 1) column vectors. Here, $\underline{\eta} = [\eta_i]$ can be formed by selecting random normal numbers from a population distributed N(0,1). In this case $(\underline{X} - \underline{\mu}_X)$ is the (M x M) variance-covariance matrix,

$$\underline{D} = \underline{C}'\underline{C} \ , \tag{89}$$

and the generation matrix $\underline{C}$ is obtained by a lower triangularization of the desired variance-covariance matrix $\underline{D}$.

The components of the vector $\underline{X}$ generated by this algorithm can have any desired correlation, as provided in the variance-covariance matrix $\underline{X}$, and can have any mean, as provided in the vector $\underline{\mu}_X$. By this method it is possible to generate correlated random normal numbers. If the covariances of $\underline{D}$ are zero, the elements of the generated $\underline{X}$ are then uncorrelated; i.e., independent. Consider a case in which it is desired to generate $\underline{X}$ in three components,

$$\underline{X} = [X_1\ X_2\ X_3] \tag{90}$$

with mean

$$\mu_{\underline{X}} = [\mu_1\ \mu_2\ \mu_3] \tag{91}$$

and variances and covariances given by:

$$\underline{D} = \begin{vmatrix} \sigma_1^2 & \sigma_1\sigma_2\rho_{12} & \sigma_1\sigma_3\rho_{13} \\ \sigma_2\sigma_1\rho_{21} & \sigma_2^2 & \sigma_2\sigma_3\rho_{23} \\ \sigma_3\sigma_1\rho_{31} & \sigma_3\sigma_2\rho_{32} & \sigma_3^2 \end{vmatrix} \tag{92}$$

In this case,

$$\underline{C} = \begin{matrix} \sigma_1 & 0 & 0 \\ \sigma_2\rho_{21} & \sigma_2\sqrt{1-\rho_{21}^2} & 0 \\ \sigma_3\rho_{31} & \sigma_3\dfrac{\rho_{32}-\rho_{31}\rho_{21}}{\sqrt{1-\rho_{21}^2}} & \sigma_3\sqrt{1-\rho_{31}^2\dfrac{(\rho_{32}-\rho_{31}\rho_{21})^2}{(1-\rho_{21})^2}} \end{matrix} \ . \tag{93}$$

The generation algorithm for the vector $\underline{X}$ (equation 90) is:

$$
\begin{aligned}
X_1 &= \sigma_1 n_1 && + \mu_1 \\
X_2 &= \sigma_2 \rho_{21} n_1 + \sigma_2 \sqrt{1-\rho_{21}^2}\, n_2 && + \mu_2 \\
X_3 &= \sigma_3 \rho_{31} n_1 + \sigma_3 \frac{\rho_{32}-\rho_{31}\rho_{21}}{\sqrt{1-\rho_{21}^2}}\, n_2 + \sigma_3 \sqrt{1-\rho_{31}^2 - \frac{(\rho_{32}-\rho_{31}\rho_{21})^2}{(1-\rho_{21}^2)}}\, n_3 && + \mu_3 .
\end{aligned}
\tag{94}
$$

In the special case in which $\underline{X}$ has a mean of zero and a variance of one; i.e., distributed N(0,1),

$$\underline{\mu} = \underline{0} \qquad \underline{\sigma} = \underline{1} \tag{95}$$

and the generation algorithm reduces to

$$
\begin{aligned}
X_1 &= n_1 \\
X_2 &= \rho_{21} n_1 + \sqrt{1-\rho_{21}^2}\, n_2 \\
X_3 &= \rho_{31} n_1 + \frac{\rho_{32}-\rho_{31}\rho_{21}}{\sqrt{1-\rho_{21}^2}}\, n_2 + \sqrt{1-\rho_{31}^2 - \frac{(\rho_{32}-\rho_{31}\rho_{21})^2}{(1-\rho_{21}^2)}}\, n_3 ,
\end{aligned}
\tag{96}
$$

where n_1, n_2, and n_3 are numbers drawn independently from a population distributed normally with a mean of zero and variance of one.

In practice, these analytic expressions for the lower triangular matrix $\underline{C}$ are not needed. One simply forms the desired variance-covariance matrix $\underline{D}$ (or the correlation matrix $\underline{R}$ if $\underline{X}$ is to be distributed N(0,1)), lower triangularizes that matrix by the Cholesky procedure (see Section 3.6.4), and uses it and the mean vector $\underline{\mu}_X$ in the generation algorithm (equation 110). The independent random normal numbers $\underline{n}$ are produced either by using a pseudo-random normal number generator directly or by using a uniform pseudo-random number generator and any of several suitable transformations.

3.6.4 Cholesky or "Square Root" Factorization. If $\underline{A}$ is a symmetric, square matrix which is positive definite (A matrix $\underline{A}$ of order N is positive definite if $\underline{x}'\,\underline{A}\,\underline{x} > 0$, for every real, nonzero N-vector $\underline{X}$), the matrix $\underline{A}$ can be factored into a lower triangular matrix $\underline{S}$ and its transpose $\underline{S}'$,

$$\underline{A} = \underline{S}\,\underline{S}'. \tag{97}$$

The Cholesky method is extremely stable, never requires interchanging to avoid small pivots, and requires the least computational labor of all decomposition schemes, largely because of the symmetry of the $\underline{A}$ matrix. If the symmetric, positive definite requirements are not adhered to, the Cholesky algorithm will break down by calling for division by zero or attempting to take the square root of a negative number.

The Cholesky or square-root algorithm for factoring the real, symmetric, positive definite matrix $\underline{A} = [a_{ij}]$ of order n into a lower triangular matrix $\underline{S} = [s_{ij}]$ and its transpose consists of three rules:

$$s_{i1} = \frac{a_{i1}}{\sqrt{a_{11}}} \qquad \begin{matrix} j = 1 \\ 1 \le i \le n \end{matrix} \tag{98}$$

$$s_{ii} = \sqrt{a_{ii} - \sum_{k=1}^{i-1} s_{ik}^2} \qquad \begin{matrix} j > 1 \\ 1 \le i \le n \end{matrix} \tag{99}$$

$$s_{ij} = \frac{a_{ij} - \sum_{k=1}^{j-1} s_{ik} s_{jk}}{s_{jj}} \qquad \begin{array}{c} j > 1 \\ 1 < j < i \leq n. \end{array} \tag{100}$$

Finally, $s_{ij} = 0$ for all $j > i$. These rules are implemented column-wise, starting with the leftmost column ($j = 1$) and proceeding down each column (toward increasing i).

The generation algorithm of equation (88) can be illustrated with a test case. Suppose it is desired to generate a vector such as, $X = [X_1\ X_2\ X_3\ X_4]$, of standard normal variables distributed N(0,1) having the correlation matrix,

$$\underline{R} = \underline{D} = \begin{vmatrix} 1.0 & 0.8 & 0.7 & 0.3 \\ 0.8 & 1.0 & 0.6 & 0.4 \\ 0.7 & 0.6 & 1.0 & 0.5 \\ 0.3 & 0.4 & 0.5 & 1.0 \end{vmatrix} .$$

The Cholesky reduction procedures the lower triangular matrix $\underline{C}$,

$$\underline{C} = \begin{vmatrix} 1.0000 & 0.0000 & 0.0000 & 0.0000 \\ 0.8000 & 0.6000 & 0.0000 & 0.0000 \\ 0.7000 & 0.0667 & 0.7110 & 0.0000 \\ 0.3000 & 0.2667 & 0.3829 & 0.8321 \end{vmatrix} .$$

The transpose of $\underline{C}$ is:

$$\underline{C}' = \begin{vmatrix} 1.0000 & 0.8000 & 0.7000 & 0.3000 \\ 0.0000 & 0.6000 & 0.0667 & 0.2667 \\ 0.0000 & 0.0000 & 0.7110 & 0.3829 \\ 0.0000 & 0.0000 & 0.0000 & 0.8321 \end{vmatrix} ,$$

from which it can be verified that: $\underline{C}'\ \underline{C} = \underline{D}$.

The matrix $\underline{C}$ is then used to generate values of $\underline{X}$ by performing the matrix-vector multiplication of equation (88) with successive values of $\underline{n}$.

CHAPTER 4

CUMULATIVE DISTRIBUTION FUNCTIONS OF ELECTRO-OPTICAL AND METEOROLOGICAL VARIABLES

4.1 General. For each simulation using the Ornstein-Uhlenbeck stochastic process (Equation 48), a raw variable must be expressed as an equivalent normal deviate (END). The transnormalization procedure described in Section 3.4 for converting a threshold x_T to a cumulative probability and then normalizing the probability can be applied to all the variables in the OPAQUE project. However, the graphical technique is impractical for even a small number of simulations. A more appropriate alternative is to use linear regression techniques to fit variously shaped distribution functions to the cumulative distributions. This procedure gives a continuous function of the form

$$P = F(x) \tag{101}$$

from which continuous probability estimates can be obtained by evaluating the function. Correspondingly, continuous variable estimates can be obtained by evaluating the function inverse

$$x = F^{-1}(P) . \tag{102}$$

There are a number of cumulative probability distribution functions which could be used to model the empirical distributions of the EO/Met variables. However, there are several restrictions which limit the number of possible CDFs. The CDF must be of a form that allows inverse transnormalization; i.e., the CDF must be readily solvable for the threshold value x_T as in equation (102). F^{-1} will exist if the function F is continuous and monotonically increasing. In general, polynomials produce negative frequencies because they do not monotonically increase, and are therefore unsuitable for modeling. The CDF must also be reducible to a linear form since the CDF modeling coefficients are to be derived by standard linear regression. The CDF should be in closed form, which allows a solution by direct substitution rather than by numerical integration or tables. The number of modeling coefficients should be relatively small; i.e., two coefficients will substantially reduce computer time and storage.

Considerable work has been done using the above constraints with some of the EO/Met variables available in the OPAQUE data base. Somerville et al (1979) developed a modeling scheme for visibility using the Weibull distribution (our first guess for the OPAQUE visual attenuation/extinction). Husar et al (1981) worked extensively with visual attenuation using the Johnson single-bounded (lognormal) distribution. Somerville and Bean (1979) suggested the Weibull distribution for wind speed. Temperature and dewpoint have been frequently modeled using the normal distribution (Boehm and Abbott, 1977). Boehm (1976) used the Johnson double-bounded distribution for relative humidity. Somerville et al (1980) have employed the Johnson double-bounded distribution to model sky cover.

No previous work has been done modeling broad-band infrared empirical distributions. USAFETAC/DNY developed a program that allows a rapid graphical comparison of the empirical distribution of a data set with each of the standard distributions being considered as a model. This program follows the probability plot concept of Law and Kelton (1982). Based on the analysis of these plots and other investigations, USAFETAC/DNY adopted a line segment fitting routine to model the empirical distributions of the broad-band infrared data.

4.2 Distribution Fitting Approach.

4.2.1 Binning Data. A prerequisite to modeling empirical distributions is to rank order the observed data. Boehm (1976) suggests a cumulative probability can then be assigned to each observation. The probabilities can then be applied to a linear regression curve fitting program. This procedure has several drawbacks, the largest being the sheer number of operations involved in a large data set. A better procedure for large data sets is what Panofsky and Brier (1965) call organizing data by class intervals that are "numerical but unequal". Here the rank ordered data are now assigned to a class or bin such that all observations within that bin are less than or equal to the threshold x_T specified for that bin but greater than the threshold value x_{T-1} of the previous bin. The class interval or bin width becomes $(x_T - x_{T-1})$ and the cumulative probability for that bin is $Pr(X \leq x_T)$. It is these cumulative probabilities that are used for the mathematical modeling.

The number, size, and width of bins is a matter of optimization. Fewer, larger bins mean more data in each bin with a corresponding smaller error due to sampling. Smaller, more numerous bins have a greater sampling error, but interpolation error is smaller. Since portions of the frequency distributions

of the EO/Met variables have limited data, the larger bin widths will allow a smoother transition in bin size from one bin to the next and reduce the number of empty or low count bins. Correspondingly, smaller bin widths in data rich spectrums will provide a better curve fit for the modeled distribution.

The final choices for the threshold values x_T and bin widths ($x_T - x_{T-1}$) resulted from evaluations of how well the modeled distribution matched the empirical distribution. Table 8 shows the threshold values for the OPAQUE variables for which modeling parameters were eventually developed. The last threshold value for each variable is set to a high enough value to include all observations greater than the last interior threshold value. The minimum exterior threshold boundary, which is not shown, often equates to zero. The only exception to this is the equivalent aerosol IR extinction. Because of errors in the measurements and approximations to LOWTRAN derived aerosol IR transmission, values greater than 100 percent are possible. With the conversion to equivalent aerosol IR extinction, values less than zero are also possible. Therefore, the minimum exterior threshold boundary for aerosol equivalent IR extinction is set to -.2 km^{-1}.

TABLE 8. Threshold Values x_T for the OPAQUE EO/Met Variables.

Visual Attenuation/Extinction (km^{-1})

.05	.10	.12	.14	.16	.18	.20	.22	.24	.26
.28	.30	.35	.40	.45	.51	.55	.60	.65	.70
.75	.80	.85	.90	.95	1.01	1.50	2.00	2.50	3.00

Aerosol Infrared Transmission (%)

30	60	90	91	92	93	94	95	96	
97.5	98.0	98.5	99	99.5	100	100.25	100.5	100.75	101
101.25	101.25	101.75	101	103	105	110			

Equivalent Aerosol Infrared Extinction (km^{-1})

-.10	-.03	-.015	-.001	.005	.01	.015	.02	.025	.03
.035	.04	.045	.05	.06	.07	.08	.09	.10	.15
.20	.40	.60	.80	1.01	2.50	20.00			

10 Wind Speed ($msec^{-1}$)

1.5	2.5	3.5	4.5	5.5	6.5	8.0	9.5	15.5	25.0

2m Wind Speed ($msec^{-1}$)

1.0	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	50.0

Cloud Cover (octas)

1	2	3	4	5	6	7	8

4.2.2 Transnormalization. Figure 5 shows an example of the conversion from a cumulative probability to a normal probability. As noted in Paragraph 3.4, a rational approximation, rather than normal probability tables, works best for computer simulations. There are several rational approximations that can be used. USAFETAC uses the rational approximation by Hastings (Abramowitz and Stegun, 1964) in the simulation efforts to convert cumulative probability to an equivalent normal deviate (END).

USAFETAC subroutine ENORMP calculates the END corresponding to the cumulative normal probability that a normally distributed variable X is less than some threshold x_T. The subroutine is based on equation 26.2.23 from Abramowitz and Stegun,

$$E(P) = T - \frac{(C_0 + C_1 T + C_2 T^2)}{1 + D_1 T + D_2 T^2 + D_3 T^3} + \varepsilon(P), \tag{103}$$

where the absolute value of the error in the probability returned is $|\varepsilon(E)| < 4.5 \times 10^{-4}$ and

$$T = \sqrt{\ln \frac{1}{P}} \quad . \tag{104}$$

The constants for the polynomial approximation are:

$$C_0 = 2.515517 \qquad D_1 = 1.432788$$
$$C_1 = 0.802853 \qquad D_2 = 0.189269$$
$$C_2 = 0.010328 \qquad D_3 = 0.001308.$$

The resultant END corresponds to a right-tail integration of the standard normal distribution. For probabilities greater than 50 percent, the subroutine uses the complement (1 - P) to give the left-tail integration from $-\infty$ to E. For probabilities less than 50 percent, the resultant END must be multiplied by -1 to account for negative ENDs. The Hastings approximation breaks down in the extremes of the normal distribution. Therefore, probabilities are truncated at the .05 percent points; i.e., less than or equal to .0005 and greater than or equal to .9995. The corresponding ENDs are -3.3 and 3.3, respectively.

USAFETAC subroutine PNORME uses similar technique to calculate the cumulative normal probability that a normally distributed variable X is less than some threshold x_T whose END is E. This is the integral of the standard normal distribution from $-\infty$ to E. The polynomial approximation from equation 26.2.18 of Abramowitz and Stegun provides the transformation,

$$P(E) = 1 - .5 \cdot (1 + C_1E + C_2E^2 + C_3E^3 + C_4E^4)^{-4} + \epsilon(E) \; , \tag{105}$$

where the absolute value of the error in the returned probability is $|\epsilon(E)| < 2.5 \times 10^{-4}$. The constants for the approximation are

$$C_1 = 0.196854 \qquad C_3 = 0.000344$$
$$C_2 = 0.115194 \qquad C_4 = 0.019527.$$

For computation efficiency in the algorithm, the inverse 4th root of one half (1.1892071) can be factored into the constants (including unity) of equation (105). This substitution yields:

$$P(E) = 1 - (C_0 + C_1E + C_2E^2 + C_3E^3 + C_4E^4)^{-4} \; . \tag{106}$$

The constants for this form of the approximation are:

$$C_0 = 1.1892071 \qquad C_3 = 0.0004091$$
$$C_1 = 0.2341002 \qquad C_4 = 0.0232216.$$
$$C_2 = 0.1369895$$

To further reduce the number of mathematical operations necessary to solve equation (105), the term in parentheses can be evaluated in factor form:

$$W = C_0 + E \{ C_1 + E [C_2 + E (C_3 + C_4E)]\} \; . \tag{107}$$

Substituting equation (107) into equation (106) the approximation becomes:

$$P(E) = 1 - W^{-4} \; . \tag{108}$$

This equation can also be expressed as:

$$P(E) = 1 - [1/(W \cdot W \cdot W \cdot W)] \; . \tag{109}$$

For cases of negative ENDs, equation (106) becomes:

$$P(E) = (C_0 + E \{ - C_1 + E [C_2 + E (-C_3 + C_4E)]\} \; . \tag{110}$$

The constants C_0 through C_4 have the same values as for the case of positive E. The factored form of the term in parantheses in equation (110) becomes:

$$W = C_0 + E\{-C_1 + E[C_2 + E(-C_3 + C_4E)]\}. \qquad (111)$$

Substituting equation (111) into equation (106), the approximation becomes:

$$P(E) = W^{-4}, \qquad (112)$$

which can also be expressed as:

$$P(E) = 1/(W \cdot W \cdot W \cdot W). \qquad (113)$$

Table 9 compares a few selected Hastings derived probabilities with probabilities extracted from the CRC Handbook of Tables for Probabilities. All derived probabilities are well within the accuracy required for simulation models.

TABLE 9. Comparison of Hastings Equivalent Normal Deviate Probabilities using USAFETAC Subroutine PNORME with Probabilities from CRC Handbook of Tables for Probabilities (1968).

END	PNORME	Probability from Tables
-3.5	0.00037441	0.0002
-3.0	0.00157918	0.0013
-2.0	0.02256308	0.0228
-1.0	0.15887636	0.1587
0.0	0.49999976	0.5000
1.0	0.84112364	0.8413
2.0	0.97743696	0.9772
3.0	0.99842083	0.9987
3.5	0.99962562	0.9998

4.2.3 __Evaluating Curve Fits.__ The goodness of fit between the observed and calculated cumulative distributions is evaluated in terms of the root mean square difference (RMS) between the observed cumulative distribution for all threshold values and those values for the mathematical function. The RMS is defined by:

$$RMS = \sqrt{\frac{1}{N}\sum_{j=1}^{N}(O_j - T_j)^2}, \qquad (114)$$

where O_j and T_j are the individual elements of the observed and theoretical distribution and N is the total number of data pairs. The maximum difference between each observed and modeled distribution is a product of the RMS calculations. After the appropriate mathematical function has been selected, both the RMS and RESMAX can be minimized by careful selection of bin threshold values.

Table 10 contains the curve fit information for the 10m wind speed for April, 0500 MST.

Table 10. Observed and Calculated Cumulative Frequency Occurrence Pr ($X \le x_T$) for Ypenburg 0500 MST April 10m Wind Speed.

Observed Threshold Wind Speed S_{T-1} msec	Weibull Cumulative Frequency $S \le s_T$ %	Cumulative Frequency $S \le s_T$ %	Residual (%)	Residual Squared (%)
1.5	11.9	13.1	-1.2	1.44
2.5	28.7	28.1	.6	.36
3.5	44.6	44.0	.6	.36
4.5	58.4	58.7	-.3	.09
5.5	71.3	71.0	.3	.09
6.5	79.2	80.6	-1.4	1.96
8.0	92.1	90.2	1.9	3.61
9.5	95.0	95.5	-.5	.25
15.0	100.0	99.9	.1	.01

The 10m wind speed, which is modeled using the standard Weibull distribution, contains nine interior bin thresholds. The sum of the residuals is 8.17 for the nine data points. The last cumulative value is set at 100 percent and is therefore not used in the RMS calculations. Using these values in equation (114) yields: $RMS = \sqrt{8.17/9} = .908\%$.

The RMS of .908 percent and RESMAX of -1.4 percent are among the lowest of any curve fits. This leads to a possible error of about 3 percent in using the Weibull distribution for the 10m wind speed.

Normally, the RMS provides a good indicator of the closeness of fit; i.e., the lower the RMS the better the fit. In the 10m wind speed example, the theoretical distribution is an excellent representation of the empirical distribution. In some cases, however, the RMS can be low while the RESMAX over a portion of the curve fit can be quite high. For example, the RMS for the Ypenburg visual extinction lognormal curve fit for July 1200 MST is 3.77 percent. The RESMAX is -10.59 percent which occurs over the lower threshold values. Table 11 shows the curve fit information for the lower ten thresholds. The RESMAX occurs with the .24 km^{-1} extinction threshold. Optimum selection of threshold bin values can minimize this type of deviation. Appendix C contains the Ypenburg modeling coefficients. Appendix D contains a summary of curve fits for Ypenburg.

TABLE 11. Observed and Modeled Cumulative Frequency Occurrence for Ypenburg 0700 MST July Visual Extinction (lognormal distribution).

Threshold Equivalent Extinction (km^{-1})	Observed Cumulative Frequency $B \le b_T$ (%)	Lognormal Cumulative Frequency $B \le b_T$ (%)
.05	0	0
.10	2	6
.12	8	12
.14	19	18
.16	25	26
.18	34	33
.20	48	40
.22	55	47
.24	64	53
.26	66	59

4.3 Mathematical Functions to Model Cumulative Frequency Distributions.

4.3.1 Johnson Double-Bounded Distribution. USAFETAC's basic modeling equation for sky cover is the Johnson double-bounded distribution, which is a member of the Johnson family of curves. The Johnson family of curves is especially useful since they are monotonically increasing functions, which alleviates the problem of most polynomials. Additionally, they allow for direct transnormalization without the generation of an intermediate cumulative probability. Somerville et al. (1978) first used the function for fitting sky cover distributions.

The equation for the Johnson double-bounded curve is:

$$\ddot{x} = \gamma + \eta \ln \left(\frac{x_T - L}{U - x_T}\right) , \tag{115}$$

where γ and η are the modeling coefficients determined from an empirical distribution, x_T is the threshold, L and U are the lower and upper bounds of the curve respectively, and $\ddot{x}$ is the END of the cumulative frequency that the variable is less than the threshold value. The Johnson double-bounded distribution is particularly suited for fitting distributions that are bounded at both end points; e.g., sky cover and relative humidity.

For sky cover, the lower bound corresponds to a zero percent coverage, while the upper bound is one hundred percent sky coverage. Therefore, equation (115) becomes:

$$\ddot{x} = \gamma + \eta \ln \left(\frac{x_T}{1 - x_T}\right) , \tag{116}$$

where x_T is some threshold sky cover in fractional coverage and $\ddot{x}$ is the END of the cumulative frequency that the actual sky cover X is less than the threshold sky cover x_T. To obtain values of sky cover from an END, equation (116) must be solved for x_T (USAFETAC subroutine XJOHNP):

$$x_T = \frac{\exp\left(\dfrac{\ddot{x} - \gamma}{\eta}\right)}{1 + \exp\left(\dfrac{\ddot{x} - \gamma}{\eta}\right)} . \tag{117}$$

The values of γ and η are obtained using a standard linear regression (USAFETAC subroutine JHNCOF). The values of $\ddot{x}$ corresponding to the percentage of time that the sky cover is less than some threshold is regressed against the interior boundary values of that category. For example, when the sky cover is observed in octas, there are nine thresholds designated as 0,1,2,3,4,5,6,7, and 8. Only the interior seven data pairs are passed to the regression scheme.

4.3.2 **Johnson Single-Bounded Distribution**. The modeling equation for visual attenuation and visual extinction is the Johnson single-bounded or lognormal distribution. The standard USAFETAC modeling distribution for visibility is the Weibull curve. Initial efforts centered on using the Weibull distribution for visual attenuation/extinction. However, the lognormal distribution (Husar et al, 1981) provided much better curve fits than the Weibull.

The standard lognormal distribution (Law and Kelton, 1982),

$$F_X(x) = \int_{-\infty}^{\infty} \frac{1}{x\sqrt{2\pi\sigma^2}} \exp\left(\frac{-(\ln x - \mu)^2}{2\sigma}\right) , \tag{118}$$

is not in closed form. However, the lognormal distribution, as a member of the Johnson family of curves, is in a closed form which allows transnormalization directly without calculation of an intermediate cumulative distribution. The equation for the Johnson version of the lognormal distribution, which is the form that will henceforth be used, is (Boehm, 1976):

$$\ddot{x} = \gamma + \eta \ln (x_T - k) , \tag{119}$$

where γ and η are the modeling coefficients determined from an empirical distribution, x_T is some threshold, k is a constant, and $\ddot{x}$ is the END of the cumulative frequency that the variable is less than the threshold value ($Pr(X \le x_T)$).

The lognormal distribution is particularly suited for distributions that are bounded on one end, where k is the lower bound the variable can assume. Often the value k is known to be zero, in which equation (119) reduces to the two parameter lognormal distribution (Johnson and Kotz, 1970),

$$\ddot{x} = \gamma + \eta \ln x_T . \tag{120}$$

To obtain values of visual attenuation/extinction, equation (121) must be solved for x_T (USAFETAC subroutine PLOGNX):

$$x_T = \exp\left(\frac{\ddot{x} - \gamma}{\eta}\right) . \tag{121}$$

The values of γ and η are obtained using a standard linear regression (USAFETAC subroutine LGNCOF) that fits the observed CDF to the equation of a straight line and minimizes the sum of the squares of the differences between the modeled distribution and the observed data. The upper and lower exterior thresholds and their corresponding cumulative probabilities are not used in the regression.

4.3.3 Weibull Distribution. USAFETAC's basic modeling curve for wind speed is the Weibull distribution. The equation for the Weibull distribution is:

$$P = 1 - \exp(-\alpha\, x_T^{\beta}) , \tag{122}$$

where α and β are the modeling coefficients from empirical distributions, x_T is the threshold, and P is the probability that the actual observation X is less than or equal to x_T, $\Pr(X \leq x_T)$. USAFETAC subroutine ENORMP completes the transnormalization process. Threshold values are obtained by solving equation (122) for x_T (USAFETAC subroutine XWEIBP):

$$x_T = \left(\frac{\ln(1 - P)}{-\alpha}\right)^{1/\beta} . \tag{123}$$

The values of α and β are obtained using standard linear regression (USAFETAC subroutine FTWEBL). Since the Weibull cumulative distribution is non-linear, equation (123) must first be linearized. Because of linearization, the curve fitting minimizes the sum of the square differences in natural logarithm space rather than raw variable space. A weighting function WF is applied to each data point that produces a minimum error in raw variable space. Appendix B describes this weighted linear regression technique.

Somerville and Bean (1979) first applied a three parameter Weibull distribution to wind speed:

$$P = C + (1 - C)(1 - \exp(-\alpha\, x_T^{\beta}) , \tag{124}$$

where C is the probability of a calm wind speed. This technique requires three modeling coefficients rather than the two of the standard Weibull. However, USAFETAC/DNO found (Project 1564) that a two parameter Weibull provided better curve fits than the three parameter version. The probability of calm is now included in the first cumulative probability bin. For example, for the first threshold of 1 $msec^{-1}$, the cumulative probability $\Pr(X \leq 1)$ includes the combined cumulative probability of calm and 1 $msec^{-1}$. The change to the two parameter version is justified since wind, for the most part, never is truly calm (see Paragraph 2.2).

USAFETAC's previous modeling efforts for relative humidity used the Johnson double-bounded distribution (Boehm, 1976). However, USAFETAC/DNY found that the Weibull distribution, when using the complement of relative humidity (100 - RH), gave better curve fits. Humidity bin widths are narrow for high relative humidities to concentrate on the change in aerosol growth.

4.3.4 Normal Distribution. USAFETAC's basic modeling distribution for temperature and dewpoint is the normal curve. As noted in Paragraph 4.1, polynomials usually are not suitable for transnormalization because portions of the curve with negative slopes produce negative frequencies; i.e., the curves are not monotonically increasing. However, a first-order polynomial of the form:

$$\ddot{x} = a + bx , \tag{125}$$

where x is the raw variable rather than a standard variable, can give the transnormalized cumulative probability directly without calculation of an intermediate probability. Equation (125) is simply the normal distribution with a mean of -a/b and a standard deviation 1/b (Boehm, 1976). This can be seen by equating the standard form of a normal equation with a mean M and standard deviation S to the linear equation form:

$$\ddot{x} = (x - M)/s = a + bx. \tag{126}$$

Since the raw variables are available, the calculated mean and standard deviation can represent the modeling coefficients rather than generating cumulative probabilities. To recover a threshold, equation (125) can be solved for x:

$$x_T = \frac{x'' - a}{b} = x'' \cdot s + M . \tag{127}$$

4.4 Probability Plots.

4.4.1 Graphical Evaluation of Cumulative Probabilities. One traditional method of selecting a distribution for modeling is by evaluating a graphical plot of the raw variable and some function of the raw variable. A histogram of the frequency distribution gives an estimate of the probability density function. While the pattern of the PDF is well defined, identification of a particular PDF from the histogram can be rather difficult. Since all the distributions USAFETAC uses for simulation are of the cumulative type, this method is not suitable for selecting a distribution. Identifying a particular distribution from a histogram of a CDF is nearly impossible.

The probability plot technique (alternatively called quantile-quantile or Q-Q plot) described by Law and Kelton (1982), Gringorten (1963), and Kimball (1960), reduces the comparison of the distribution of data with a mathematical distribution to an evaluation of how well a data plot fits a straight line. Although probability plots do not always indicate a suitable modeling distribution, the technique does provide a great deal of information on how various sections of an empirical distribution follow certain mathematical distributions.

The objectives of the probability plot technique are to reduce one of the standard distribution functions to a linear form, evaluate this equation in terms of the cumulative probability, and plot the raw variable (abscissa) against the result (ordinate). The general form of a linear cumulative distribution function is:

$$M(x') = A + B\, N(x) , \tag{128}$$

where A and B are the location and scale parameters respectively, x is the threshold value, x' is the cumulative probability, $M(x')$ is some function of the cumulative probability, and $N(x)$ is some function of the threshold value. Typically, a cumulative distribution function must be solved for $N(x)$ to be put in the form of equation (128), which gives the function inverse $F^{-1}(P)$. A plot of each raw variable X_i against $N(x_i)$ will produce a straight line, provided the distribution of the data is the same as the mathematical distribution function.

Equation (128) requires estimates for location and scale parameters A and B. These parameters do not have to be precisely determined. Any differences between A and B and the true values for the scale and location parameters will still produce a straight line, only the slope will be different from 1 and the line will not pass through the origin. A convenient choice for the location and scale parameters are 0 and 1 respectively.

4.4.2 Estimates for Cumulative Probability. The cumulative distribution function F_X has been defined as (equation 24):

$$F_X = Pr\,(X \leq x) .$$

If the data to be analyzed is rank ordered in ascending order, each data point becomes what Law and Kelton call the ith order statistic for all the X_i's. A reasonable approximation to F_X is the proportion of all X_i's that are less than x. A simple i/N estimate tends to give slightly biased results, particularly for the extremes of the cumulative probability. Kimball (1960) shows that the estimate of the empirical cumulative distribution function F_X can be represented as:

$$\hat{F}_X(X_i) = \frac{i}{N+1} . \tag{129}$$

Gringorten (1963) gives a more general form for

$$\hat{F}_X(X_i) = \frac{i - A}{N + 1 - 2A} , \tag{130}$$

where $0 \leq A < 1$. The value that A takes on depends on the type of function $M(\dot{x})$ is in equation (128). The most frequently cited value is A = .5, which yields:

$$\hat{F}_X(X_i) = \frac{i - .5}{N} . \qquad (131)$$

This amounts to taking the middle value from (i-1)/N to i/N.

Equation (132) is general and has been used for many purposes. When the cumulative probability is used explicitly in $M(\dot{x})$, Gringorten recommends A = 0 for better estimates of the cumulative probability,

$$\hat{F}_X(X_i) = \frac{i}{N + 1} . \qquad (132)$$

When $M(\dot{x})$ calls for the conversion of the cumulative probability to an END, Kimball (1960) lets A = .375, which produces an estimate of the cumulative probability of:

$$\hat{F}_X(X_i) = \frac{i - .375}{N + .25} . \qquad (133)$$

4.4.3 <u>Generation of Quantiles.</u> The Johnson family of curves (equations 115 and 119) are already in the linear form of equation (128):

$$\ddot{x} = \gamma + \eta \ln \left(\frac{x_T - BL}{BU - x_T}\right)$$

$$\ddot{x} = \gamma + \eta \ln (x_T - k).$$

Using estimates for the location and scale parameters as 0 and 1 respectively, the above equations become:

$$\ln \left(\frac{x_T - BL}{BU - x_T}\right) = \ddot{x} \qquad (134)$$

$$\ln (x_T - \kappa) = \ddot{x} . \qquad (135)$$

Equations (134) and (135) are in inverse function F^{-1} form. The user supplies the upper (BU) and lower (BL,k) bounds for the Johnson distributions. In many cases, the lower bounds can be set to zero for meteorological variables. A small increment (.001) is added to the terms in parenthesis in to prevent taking logarithms of zero. USAFETAC subroutine ENORMP converts the cumulative probability to an END. Since equations (134) and (135) both involve the exponential of an END, equation (133) provides the estimate of the cumulative distribution. The plotted points for the two Johnson curves, therefore, are in the form of:

$$(F(X_i),\ F^{-1}(\frac{i - .375}{N + .25})) . \qquad (136)$$

The Weibull distribution is not in the linear form of equation (128). Using a slightly different form of the equation which includes the shape (α) and scale (β) parameters, the Weibull distribution is (Law and Kelton):

$$P = 1 - \exp \left(\frac{x_T}{\beta}\right)^{\alpha} . \qquad (137)$$

Conversion to a linear form, where Q = 1 - P, is straightforward.

$$1 - P = \exp - \left(\frac{x_T}{\beta}\right)^{\alpha}$$

$$\ln Q = - \left(\frac{x_T}{\beta}\right)^{\alpha}$$

$$\ln(-\ln Q) = \alpha \ln x_T - \alpha \ln \beta \,. \tag{138}$$

Letting the estimates for both the shape and scale parameters be 1, equation (138) becomes:

$$\ln x_T = \ln(-\ln Q) \,. \tag{139}$$

Since equation (139) involves the double natural logarithm of a function of the cumulative probability (1-P), equation (132) provides the estimate of the cumulative distribution:

$$\hat{F}_X(X_i) = 1 - \left(\frac{i}{N+1}\right) = \frac{N - i + 1}{N + 1} \,. \tag{140}$$

The plotted points for the Weibull distribution must be in the form of:

$$\left(\ln X_i,\ \ln\left(-\ln \frac{N - i + 1}{N + 1}\right)\right) \,. \tag{141}$$

Since x_T in equation (137) must be positive, an offset is added to all X_i's in equation (141). This offset is equal to the absolute value of the largest lower boundary of the variable, which allows all input X_i's to be positive.

The normal distribution, in the form of equation (126), reduces to a simple expression by letting the mean be zero and the standard deviation be one:

$$x_T = \ddot{x} \,. \tag{142}$$

The END again is calculated by the algorithm of Abramowitz and Stegan described in Section 4.2.2. Since equation (142) involves an END, equation (133) provides the estimate for the cumulative distribution. The plotted points for the normal distribution are in the form of:

$$\left(X_i,\ F^{-1}\left(\frac{i - .375}{N + .25}\right)\right) \,. \tag{143}$$

The exponential distribution is given by:

$$F(X_i) = 1 - \exp\left(-\frac{x_T}{\beta}\right) , \tag{144}$$

where β is the scale parameter. Note that for a shape (α) parameter of 1, equation (137) for the Weibull distribution reduces to exactly the exponential distribution. Equation (144) is easily reduced to a linear form,

$$x_T = -\beta \ln(1 - F(X_i)) . \tag{145}$$

For a scale parameter of 1, the inverse function F^{-1} becomes:

$$x_T = -\ln(1 - P) . \tag{146}$$

Since equation (146) involves the probability, equation (132) provides the estimate for the cumulative probability. The plotted points for the exponential distribution therefore are in the form of:

$$\left(X_i,\ -\ln\left(\frac{N - i + 1}{N + 1}\right)\right) . \tag{147}$$

4.4.4 Quantile Plots for Selection of CDFs. The quantile plots give a visual assessment as to how well the empirical distribution fits a particular mathematical function. A straight line indicates

that the empirical distribution follows the mathematical distribution. Usually only portions of the quantile plot follow a straight line, indicating those blocks of data which best fit the distribution. The y-axis represents the first quantile for each distribution. For the normal and exponential distributions, the first quantile is the raw variable. The first quantile for the two Johnson curves and the Weibull distribution is a function of the natural logarithm of the threshold and boundary conditions. The second quantile x-axis plot is a function of the estimated cumulative frequency.

Figures 8 through 12 show quantile plots for the five test distributions using the Ypenburg visual extinction for 0300 MST February. The visual extinction was eventually modeled with the Johnson single-bounded distribution. The 0300 MST curve fit has a RMS of 2.89 and a RESMAX of 6.00 percent, which slightly higher than average for the visual extinction. The normal distribution clearly deviates from a straight line and could never be considered as a model for the visual extinction. The exponential and Weibull distributions, although closer to a straight line than the normal, are still not the best choices. The two Johnson plots are similar in that the central portion of the data fit the distribution while the upper and lower portions deviate considerably. Choosing the best distribution for the visual extinction from among the two Johnson distributions, based solely on the quantile plots, is impossible. In this particular case, the quantile plots eliminate several potential distributions and indicate those distributions which require curve fitting to establish the best modeling distribution.

Quantile plots can be quite useful for ascertaining which portions of the empirical distribution fit a particular mathematical function. Figures 13 through 17 show the quantile plots of the five test distributions using the Ypenburg equivalent aerosol IR extinction 8-12 microns for 0300 MST February. All of the plots show the same pattern where the test distribution can be used to model the lower three fourths of the data. None of the distributions can handle the sharp increase in the CDF in the region where the inverse function (quantile 2) nears one. Figure 18 shows an example of this sharp increase for the equivalent aerosol IR extinction CDF. The quantile plots show that a single curve fit cannot be used to develop modeling coefficients. An alternate approach is to model the upper portion of the data with a different pair of coefficients. This technique requires four modeling coefficients instead of the normal two.

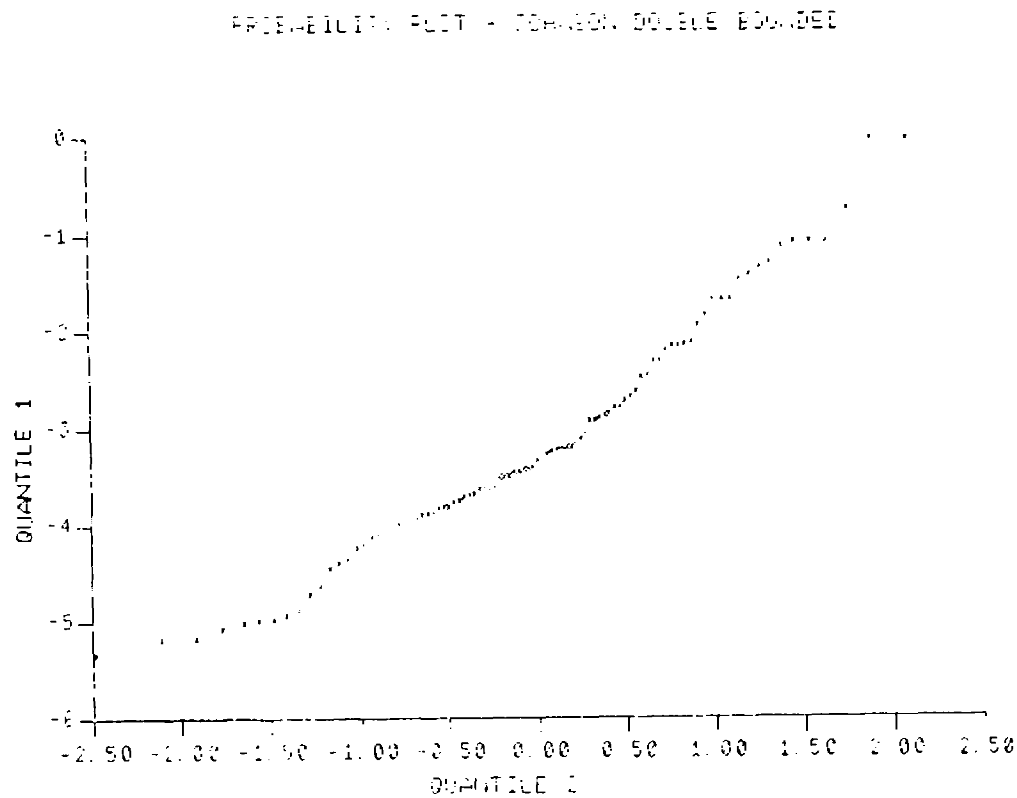

Figure 8. Quantile-Quantile Plot for the Ypenburg 0300 MST February Visual Extinction Using the Johnson Double-bounded Distribution. Quantile 1 is a function of the natural logarithm of the threshold and Quantile 2 is a function of the CDF of the distribution.

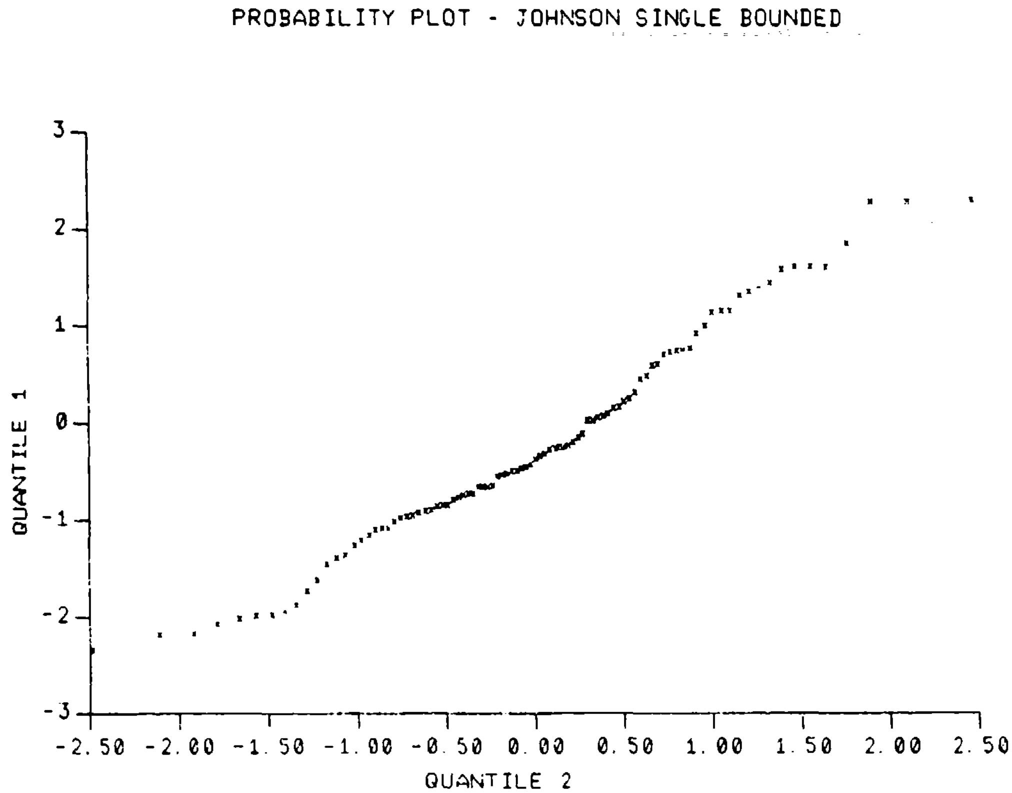

Figure 9. __Quantile-Quantile Plot for the Ypenburg 0300 MST February Visual Extinction Using the Johnson Single-bounded Distribution.__ Quantile 1 is a function of the natural logarithm of the threshold and Quantile 2 is a function of the CDF of the distribution.

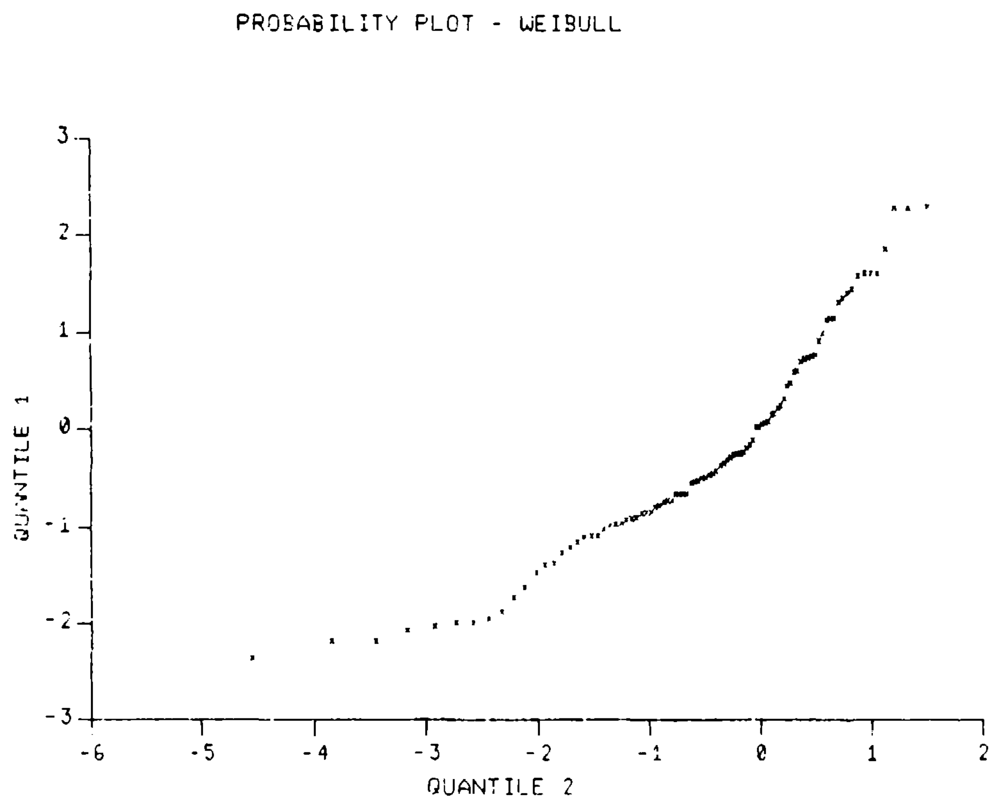

Figure 10. __Quantile-Quantile Plot for the Ypenburg 0300 MST February Visual Extinction Using the Weibull Distribution.__ Quantile 1 is the logarithm of the threshold and Quantile 2 is a function of the CDF of the distribution.

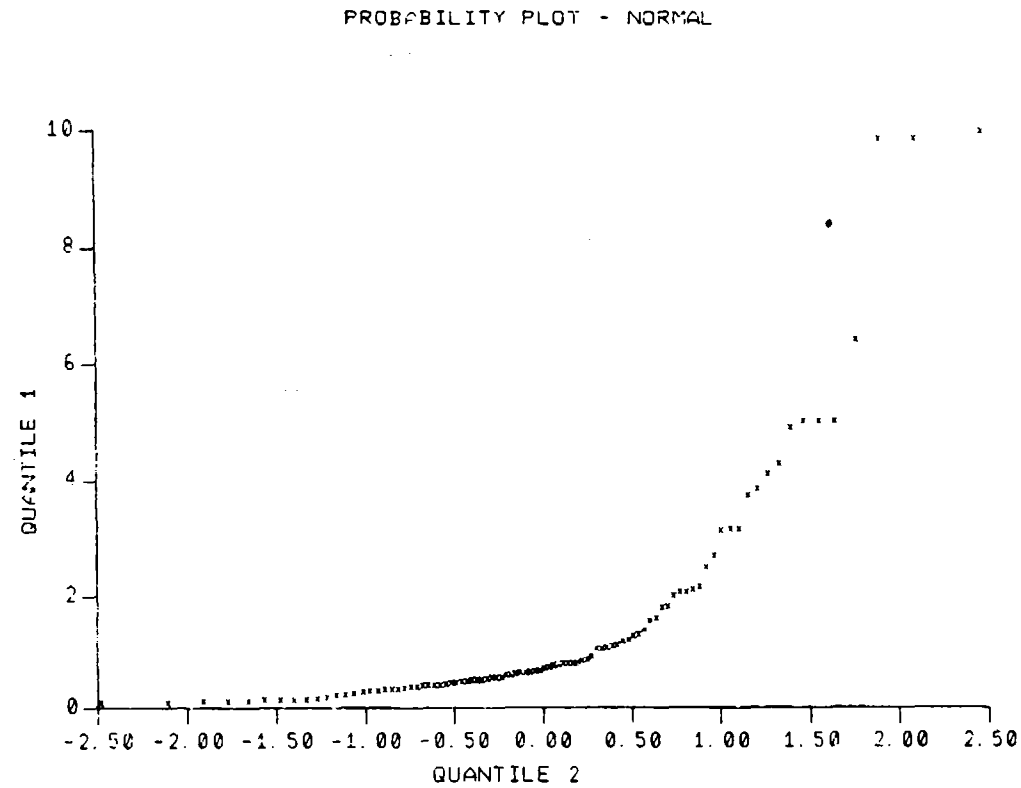

Figure 11. Quantile-Quantile Plot for the Ypenburg 0300 MST February Visual Extinction Using the Normal Distribution. Quantile 1 is the threshold and Quantile 2 is a function of the CDF of the distribution.

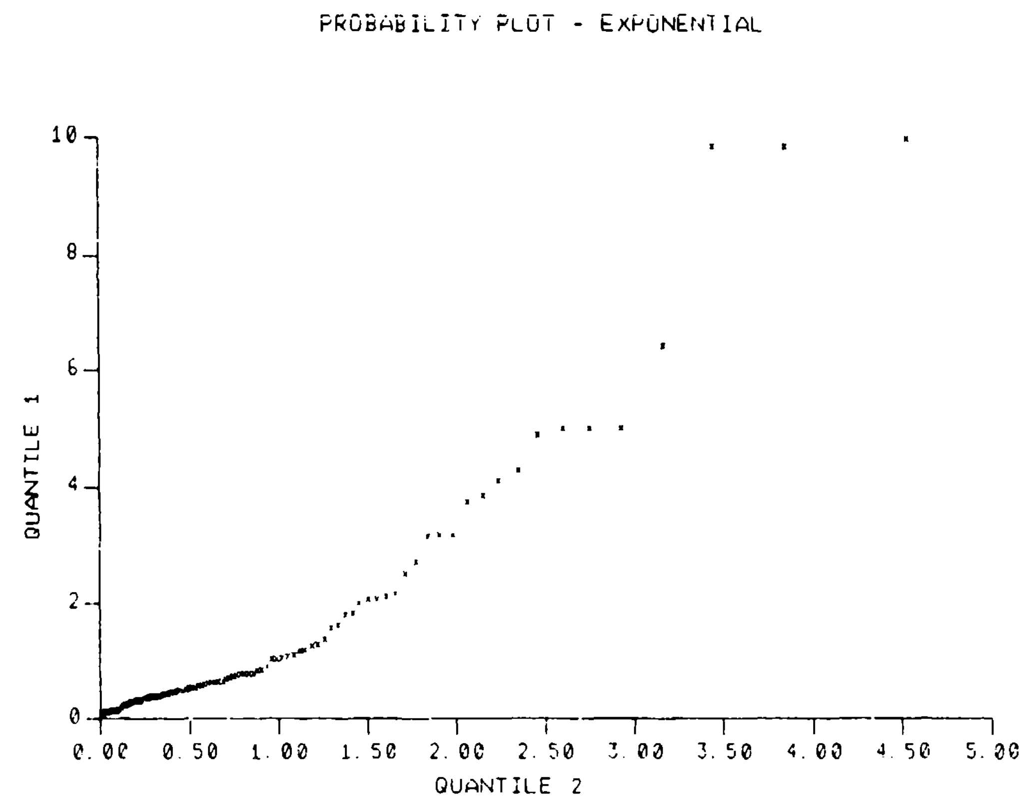

Figure 12. Quantile-Quantile Plot for the Ypenburg 0300 MST February Visual Extinction Using the Exponential Distribution. Quantile 1 is the threshold and Quantile 2 is a function of the CDF of the distribution.

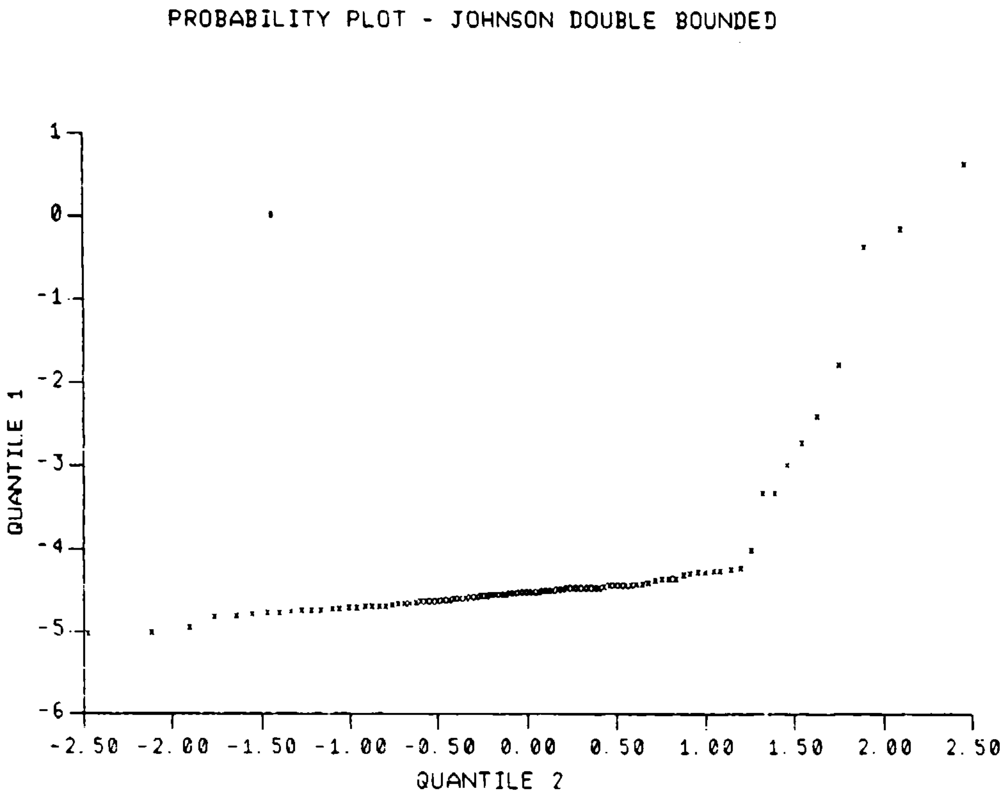

Figure 13. Quantile-Quantile Plot for the Ypenburg 0300 MST February Equivalent Aerosol IR Extinction 8.0 - 12.0 Microns using the Johnson Double-bounded Distribution. Quantile 1 is a function of the natural logarithm of the threshold and Quantile 2 is a function of the CDF of the distribution.

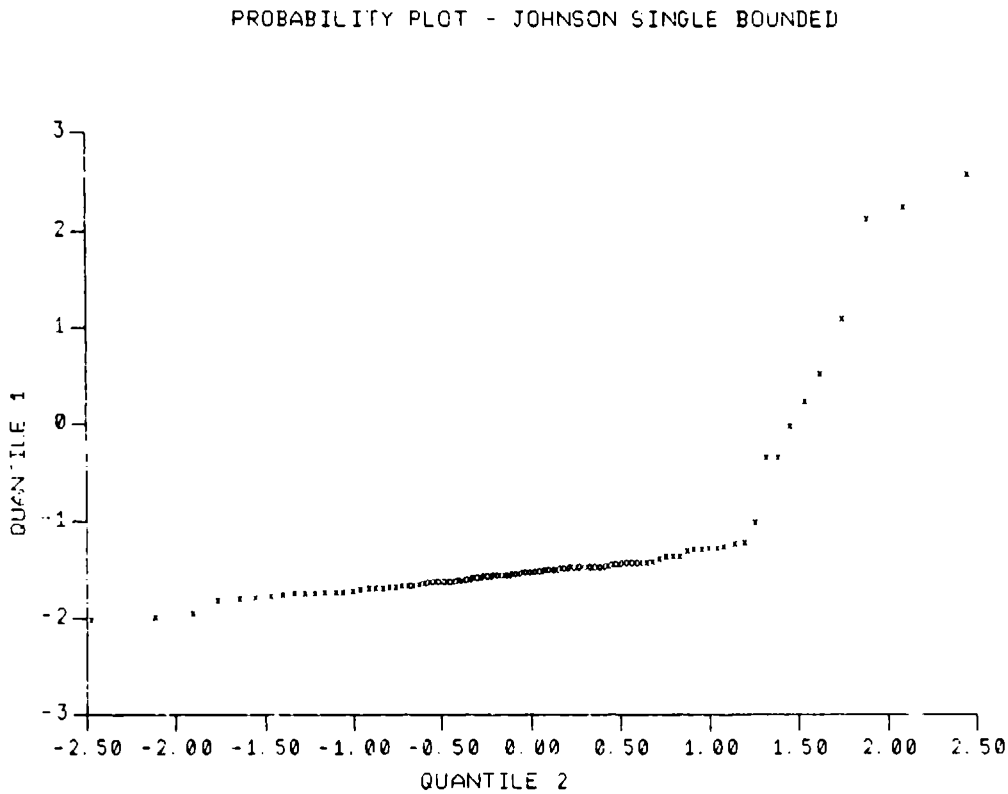

Figure 14. Quantile-Quantile Plot for the Ypenburg 0300 MST February Equivalent Aerosol IR Extinction 8.0 - 12.0 microns Using the Johnson Single-bounded Distribution. Quantile 1 is a function of the natural logarithm of the threshold and Quantile 2 is a function of the CDF of the distribution.

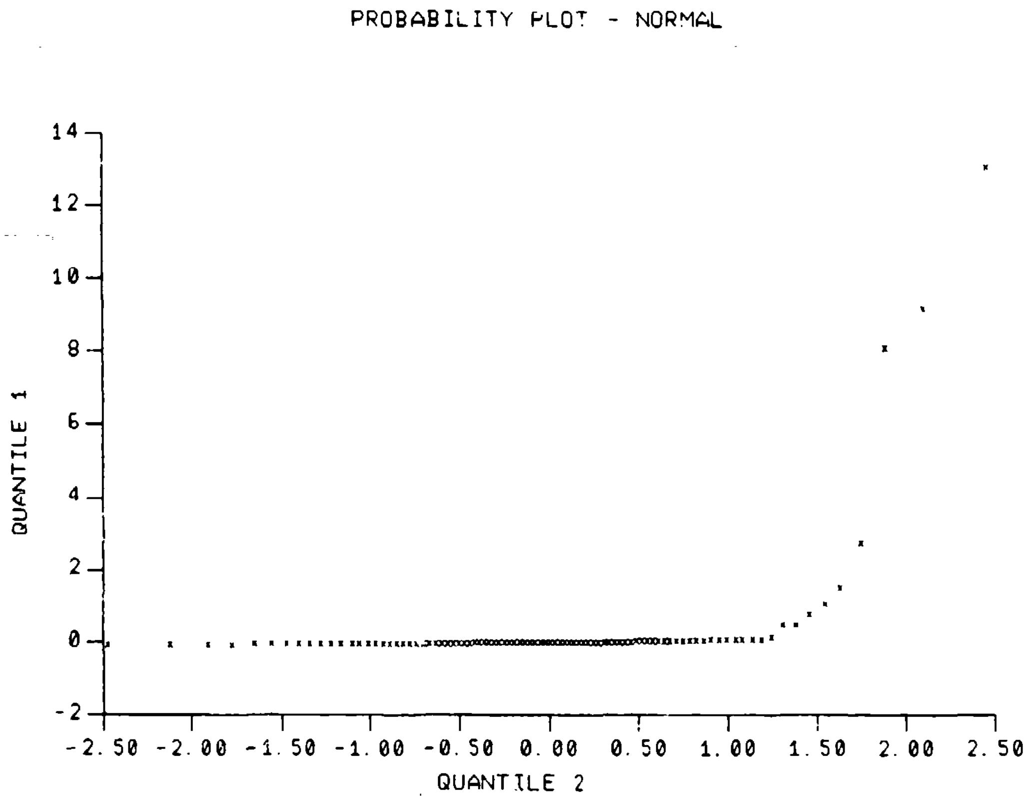

Figure 15. <u>Quantile-Quantile Plot for the Ypenburg 0300 MST February Equivalent Aerosol IR Extinction 8.0 -12.0 microns Using the Weibull Distribution.</u> Quantile 1 is the logarithm of the threshold and Quantile 2 is a function of the CDF of the distribution.

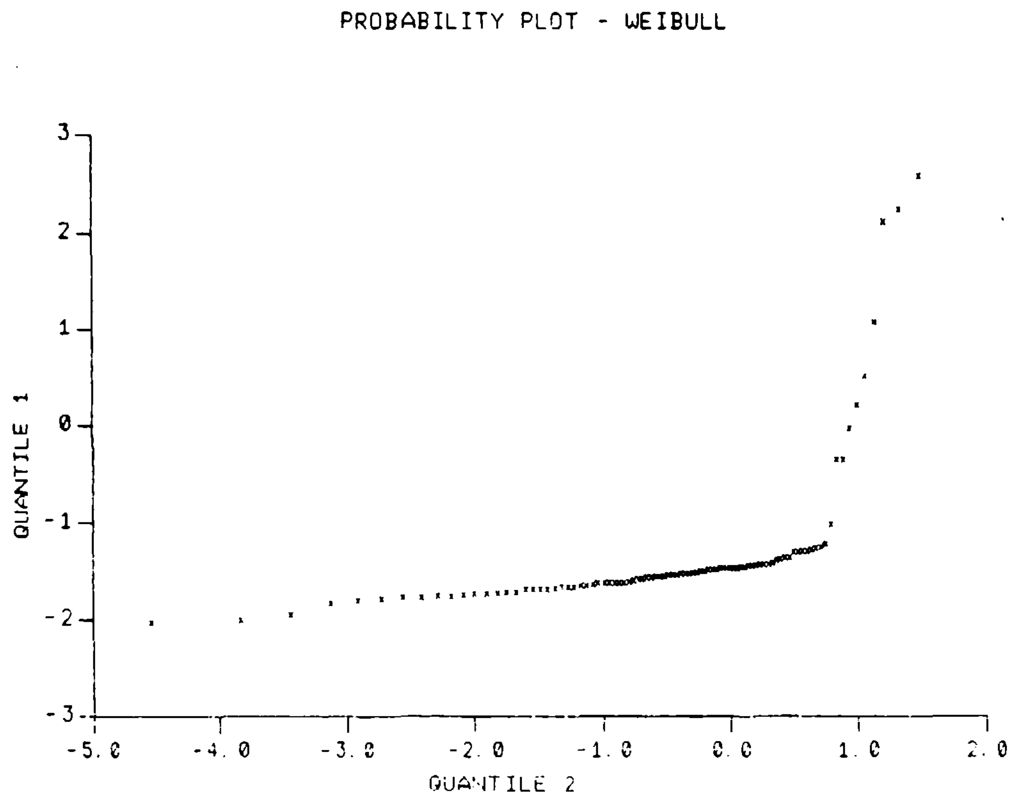

Figure 16. <u>Quantile-Quantile Plot for the Ypenburg 0300 MST February Equivalent Aerosol IR Extinction 8.0 - 12.0 microns using the Normal Distribution.</u> Quantile 1 is the threshold and Quantile 2 is a function of the CDF of the distribution.

PROBABILITY PLOT - EXPONENTIAL

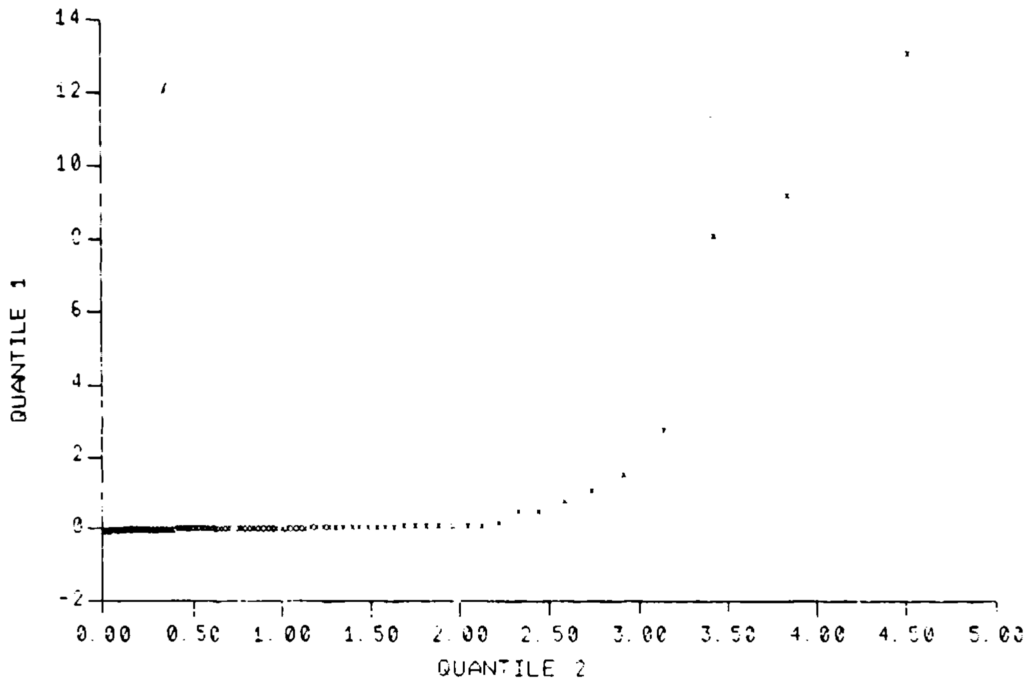

Figure 17. Quantile-Quantile Plot for the Ypenburg C300 MST February Equivalent Aerosol IR Extinction 8.0 - 12.0 Microns using the Exponential Distribution. Quantile 1 is the threshold and Quantile 2 is a function of the CDF of the distribution.

4.5 Line Segment Modeling.

4.5.1 Infrared Cumulative Distribution Modeling. All attempts to model both the empirical infrared transmission and equivalent aerosol infrared extinction using the standard modeling functions resulted in very poor curve fits. The Weibull distribution was the best fitting curve, but RMS differences between the empirical and modeled CDFs still averaged better than fifteen percent. The probability plots described in Paragraph 4.4 show that by dividing the CDF into a high transmission and a low transmission portion, two different distribution functions can be used to model the data. This generally is not an effective method of modeling because of the difficulty in selecting the break point for the CDF and the increased complexity of the overall modeling effort.

The aerosol extinction CDF is very asymetrical, with a rapid increase in cumulative occurrence as the extinction values increase. The CDFs for the IR transmission are similar. Shettle et al. (1979) show a similar comparison for visual and IR transmittance CDFs. The increase tended to be greater in the summer months during the afternoons. This is a reflection of the smaller number of low visibility cases during summer afternoons. Figure 18 shows the cumulative frequency for the July aerosol IR extinction 3.4 - 5.0 microns at 0300 MST (solid line) and 1500 MST (dashed line). The conversion algorithm for the Barnes transmission data produces slightly negative values of equivalent aerosol extinction for very high transmission values. The increase in the CDF for the morning extinction is most rapid from 0.0 km^{-1} to +.05 km^{-1}. Figure 19 shows a similar comparison for the January 8.0-12.0 micron equivalent aerosol IR extinction. The rapid increase in the 0300 MST CDF (solid line) again occurs in higher values of extinction than does the 1500 MST CDF (dashed line). However, the difference between the two curves is much smaller than in the summertime case.

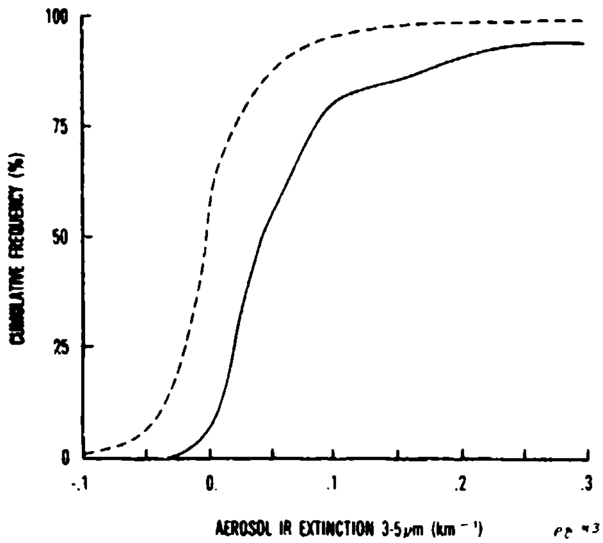

Figure 18. Cumulative Frequency Distribution for Ypenburg July Equivalent Aerosol Extinction 3.4 - 5.0 Microns at 0300 MST (solid line) and 1500 MST (dashed line).

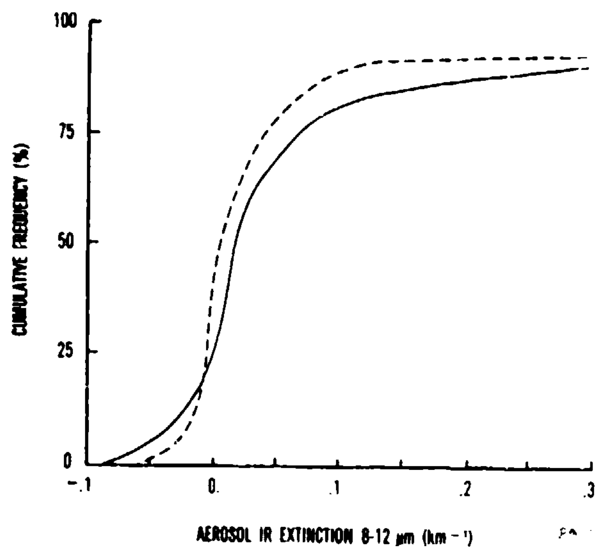

Figure 19. Cumulative Frequency Distribution for the Ypenburg January Equivalent Aerosol IR Extinction 8.0 - 12.0 Microns at 0300 MST (solid line) and 1500 MST (dashed line).

In the 8.0 - 12.0 micron case, the two extinction CDFs cross near -.01 km^{-1}. Nearly all the winter months CDFs for both IR bands show this crossover, while none of the summer curves for either IR band do. The 0300 MST CDF has a slightly larger number of high visibility cases. Since nearly all the winter hours show a similar crossover, a larger data sample would probably show this same pattern.

Since the CDF eventually chosen to model the equivalent aerosol IR extinction must adhere to the requirements presented in Paragraph 4.1, several potential but more complicated distribution functions could not be considered for modeling the EO variables. USAFETAC/DND previously experienced a similar problem in which the RMS for a particular modeling distribution was too high. Lilius et al. (1982) developed a forward-backward line segment selection (LSS) technique for USAFETAC Project 2502. While not as precise as a mathematical function, the LSS can produce a better duplication of the empirical cumulative distribution provided a sufficient number of line segments are chosen. USAFETAC/DNY initially adopted the Lilius et al. approach, but later modified the technique so as to require only one pass through the cumulative binned values.

4.5.2 **Line Segment Fitting.** The USAFETAC/DNY line segment fitting technique, developed by Lt Col Pershing Hicks, requires that the CDF be divided into a predetermined number of line segments based on the input thresholds and corresponding probabilities. The y-values for each line segment are obtained by fitting the observed CDF to the equation of a straight line using standard linear regression (USAFETAC subroutine FTLNSG). The regression for each segment includes the data points in the following line segment to minimize the error of fit in all succeeding line segments. The input thresholds, which represent abscissa x-values, must be retained to recover the y-values from the inverse transnormalization process. The resulting ordinate y-values for each line segment are stored in compacted form for later retrieval in much the same fashion as the coefficients for the standard mathematical functions. Appendix E describes the DNY line segment fitting technique.

For the infrared modeling, the line segment fitting routine uses 28 pairs of thresholds and cumulative probabilities. Each line segment contains four data points, giving a total of nine line segments. The first and last points represent cumulative probabilities of 0 and 100 percent, respectively. Therefore, only 26 interior threshold values need be given. The two exterior thresholds represent values of the variable that rarely, if ever, occur. For example, the two exterior thresholds for the equivalent aerosol IR extinction are -.2 km^{-1} and 20 km^{-1}. If an observation would fall outside these boundaries, the observation is set to fall in the last exterior bin. The resultant (x,y) end point to each line segment is shared with the beginning point for the next line segment. Although not required by the line segment fitting routine, the (x,y) value is designed to coincide with a theshold value x_T.

The line segment fitting scheme described above produces ten (x,y) data pairs. Since the first and last data pairs have been preselected to $(X_1,0)$ and $(X_{10},100)$, respectively, only eight interior y-values need be calculated and stored. For the equivalent aerosol IR extinction, these two data pairs are: (-.2, 0.) and (20, 100). The x-value thresholds are the same for all curve fits and need not be maintained with each coefficient file. To keep the modeling coefficient file similar to other model curves, USAFETAC/DNY uses the y-value storage routine of Lilius et al. to compact the eight y-values into two computer words.

4.5.3 **Y-Value Storage.** Four computed y-values can be conveniently stored in a single IBM 4341 integer 32-bit word. Each IBM 8-bit segment (byte) can store an integer from 0 to 2^8-1, or 255. If the range of computed y-values (0 to 100 percent) is represented by the integer range of 0 to 250, a single y-value can be scaled to fit in each byte by multiplying the y-value by 250 and keeping the integer portion of the result. This allows storage of y-values to the nearest 0.2 percent, with all odd tenths being rounded up.

This scaling works only for the three right-most bytes, for in the left-most byte the first bit is reserved for the sign. The largest (smallest) integer that can be stored in this byte is $\pm 2^7$-1 or ±127. Therefore, the left-most byte must be scaled from -125 to +125. To combine the four scaled y-values, the left-most byte is multiplied by 2^{24}, the second by 2^{16}, the third by 2^8, and the right-most byte by 2^0. Adding the results yields a 32-bit "signed" binary number that represents the four y-values to the nearest 0.2 percent of the fitted y-values. A reverse procedure allows recovery of the compacted y-values.

Transnormalization is by indirect methods; that is, an intermediate cumulative probability must be calculated before conversion to an END. USAFETAC subroutine PLNSGX converts threshold value to a cumulative probability. USAFETAC subroutine ENORMP, described in Paragraph 4.2.2, is the transnormalizing function. Likewise, to obtain a threshold from a simulated END, USAFETAC subroutine PNORME first converts the END to a cumulative probability and then USAFETAC subroutine XLNSGP converts the probability to a threshold.

The two Ypenburg 8.0 - 12.0 micron equivalent aerosol IR extinction coefficients for 0200 MST February demonstrate how the compaction works. The ten (x,y) data pairs are:

-.2	-.015	.01	.025	.04	.09	.20	.8	20.
0.0	.112	.448	.608	.720	.840	.900	.976	1.00

The first and last y-values, 0. and 1.00, respectively, are predefined and need not be stored. The first storable value is .112 and will be compacted using a scale of -125 to +125, giving a -97. The third, fourth, and fifth y-values are scaled from 0 to 250 and yield 112, 152, and 180.

Using the compaction multiplication factors described above, the four compacted values are: -1627389952, 7340032, 38912, and 180.

Adding these values gives a compacted, scaled integer representing the first four storage y-values: -1620010828. A similar method gives an integer coefficient of 1440408052 for the second four storage y-values.

CHAPTER 5

CORRELATIONS OF ELECTRO-OPTICAL AND

METEOROLOGICAL VARIABLES

5.1 **Correlation Coefficient.** All USAFETAC simulation models require the linear cross correlations between variables or linear correlations of a single variable with time (sometimes called temporal, serial, or auto correlation). Since the electro-optical and meteorological variables are essentially a continuous series, the Pearson product-moment (PPM) method for calculating linear correlations provides the best estimate of the true correlation. The PPM correlation coefficient also minimizes the standard error. The PPM correlation r_{xy} between two variables x and y is given by:

$$r_{xy} = \frac{\Sigma\,[(X_i - \bar{X})\,(Y_i - \bar{Y})]}{\sqrt{\Sigma\,(X_i - \bar{X})^2}\;\sqrt{\Sigma\,(Y_i - \bar{Y})^2}}\,. \qquad (148)$$

Here the means $\bar{X}$ and $\bar{Y}$ are:

$$\bar{X} = (1/N)\,\Sigma\,X_i, \qquad \bar{Y} = (1/N)\,\Sigma\,Y_i, \qquad (149)$$

the standard deviations s_x and s_y are:

$$s_x = [1/N\,\Sigma\,(X_i - \bar{X})]^{1/2}, \qquad s_y = [1/N\,\Sigma\,(Y_i - \bar{Y})]^{1/2}, \qquad (150)$$

and the covariance of X and Y is:

$$\mathrm{Cov}\,(X,Y) = \frac{\Sigma[(X_i - \bar{X})\,(Y_i - \bar{Y})]}{N}\,. \qquad (151)$$

A more convenient computational form of the PPM linear correlation coefficient eliminates prior knowledge of the mean:

$$r_{xy} = \frac{N\,(\Sigma\,X_i\,Y_i) - (\Sigma\,X_i)\,(\Sigma\,Y_i)}{[N\,(\Sigma\,X_i^2) - (\Sigma\,X_i)^2]^{1/2}\cdot[N\,(\Sigma\,Y_i^2) - (\Sigma\,Y_i)^2]^{1/2}}\,, \qquad (152)$$

where the summation is $i = 1,\ldots,N$.

If the sample size N is large and X and Y are relative large numbers with means not equal to zero, equation (149) can have considerable computational round-off error. The amount of error depends on the number of significant digits retained on a particular computer system. To alleviate this, the raw variables are transnormalized before calculating the linear correlation. This results in a two-fold improvement in the correlation process. First, the variables are now normally distributed. The means should equal zero and the standard deviation should equal one, which considerably reduces the round-off error. Second, many, but not all, non-linear effects are taken into account (Boehm, 1976). A continuous one-to-one relationship, as we have in the OPAQUE data base, will become quasi-linear if both variables are transnormalized.

5.2 **Correlation Coefficient Development.** Original correlation development centered on grouping 3 consecutive hours of observations together to increase the number of observations available for generation of the transnormalizing function. Since the observations are in local solar time, tests for solar influence involved different observation groupings. However, from previous modeling with several of the meteorological variables, the grouping significantly reduces the serial correlation. This is particularly true with any variable that involves temperature; e.g., dewpoint, equivalent aerosol IR extinction, where the error was as much as 20 percent. Unlike some variables such as cloud cover, which is not subject to many sudden changes, temperature routinely rises and falls. Thus, any grouping returns an average of the 3 hours and may not be representative of any hour in the grouping.

There is reason to suspect the correlations in the remaining meteorological and electro-optical variables as well. Transnormalizing functions and serial correlations are therefore more reliable using 1-hour time bins for each month. The increase in the number of transnormalizing coefficients for 1-hour time bins is more than offset by the improvement in the serial correlation.

5.3 Effect of Random Error on Correlation Coefficients.

5.3.1 Random Errors of Observation. A subtle, but potentially more damaging effect on the correlation coefficient is that of random observation error. Every observation is subject to some random error in the actual observation measurement and in mathematical processing of the measured quantity. For the elements in the OPAQUE data base, this includes a number of potential sources for random error. Measurement errors can be systematic and accidental measuring errors, such as sensor calibration errors and measurements spread over an observation period. Mathematical processing errors are of two types. First, there are errors in transcribing and reporting the observation for data reduction and tape storage. Second, there are errors in preparing the observations for analysis. These include errors in deriving new variables such as the equivalent aerosol IR extinction, in building the cumulative distributions, in deriving the coefficients that model the cumulative distributions, and in building the simulation model.

A quantitative estimate of the relative error, although not a precise measurement, can be used to assess the usefulness of the data. The Format Specifications for OPAQUE Data Bank Tapes (1981) defines the relative error as:

$$\text{Relative Error} = \frac{(\text{measured value} - \text{correct value})}{\text{measured value}} . \tag{153}$$

The Ypenburg group has provided relative errors for the optical and infrared transmissions. The reliability of the optical and infrared data is considered good (reliability code 4) based on repeated instrument calibrations. The relative error of the data is below 5% (2% for the IR transmissometer), which is acceptable for developing both serial and cross correlations. Although most of the man-made disturbances such as people and vehicles have been removed, there may be a few observations that still retain these disturbances.

5.3.2 Error in Correlation. By assuming all the OPAQUE observations contain error, the linear correlation between two variables or the serial correlation of a single variable can be expressed as the product of the measured correlation and an error term. Brooks and Carruthers (1953) expands the basic equation of correlation to show that the actual correlation is larger than the correlation from the measured data (derived in Appendix F):

$$r_{xy} = \frac{\sigma_\alpha \sigma_\beta}{\sigma_x \sigma_y} \cdot r_{\alpha\beta} , \tag{154}$$

where X and Y are measured variables whose random errors are d and e respectively, α and β are the deviations of the observed values from their means, and σ is the standard deviation for x, y, α, β.

The difference between the correlation corrected for random errors of observation and the measured correlation can be simply expressed as:

$$\rho_m = \rho_e^{\,2} \rho_c , \tag{155}$$

where ρ_m is the measured correlation, ρ_e is the correlation of random error, and ρ_c is the corrected correlation. Since there is random error in both the X and Y variables, the random error term is the product of two random errors of observation:

$$\rho_m = \rho_{ex} \rho_{ey} \rho_c . \tag{156}$$

5.4 Serial Correlation.

5.4.1 Markov Model Assumption. For an autoregressive (AR), first-order Markov model, the serial correlation ρ (correlation in the t-dimension) follows an exponential decay:

$$\rho = \rho_1^{\,n\Delta t} \tag{157a}$$

$$= \exp^{-\beta n\Delta t} , \tag{157b}$$

where ρ_1 is the serial correlation of unit of time, n is the number of time steps, and β is the autocorrelation coefficient (see Appendix A). Therefore, for a Markov model, simulated observations spaced Δt units apart will have a correlation $\rho_{\Delta t}$,

$$\rho_{\Delta t} = \rho_1^{\Delta t} . \tag{158}$$

A slightly different form to aid in computing a serial correlation based on a known exponential is:

$$\rho(t)^{1/t} = \rho_1 . \tag{159}$$

Since the USAFETAC simulation models are based on the Markov model, the existing USAFETAC models can be employed if the serial correlations of the OPAQUE variables follow an exponential decay. Otherwise, new models need be developed.

5.4.2 **Combining Correlation Coefficients.** Serial correlations for each of the OPAQUE variables were computed using time lags of 1, 2, 3, 6, 9, 12, 18, 24, 36, and 48 hours. To calculate the serial correlation for a particular variable for a particular month, the 4 years of data for that month (say 4 Aprils) are arranged chronologically. At this point, two avenues are possible. The most straightforward one is to place a pad of 50 null observations between each month's data, which corrects for the false correlation produced between the last observation of one month and the first observation of the next month. This accounts for the chronological break between the 2 months, and allows for serial correlations with time lags out to 48 hours. The observations are then converted to equivalent normal deviates (ENDs) using the appropriate transnormalizing function.

This method of combining correlation coefficients works satisfactorily in most cases. However, if the mean of one of the years is significantly higher or lower than the mean of the other 3 years, the resulting serial correlation coefficient will be affected. This problem is further magnified when the number of observations in each month vary from year to year. Both the variance and covariance are affected, as can be seen from the simplified two variable sample correlation coefficient $r_{t,t+\Delta t}$,

$$r_{t,t+\Delta t} = \frac{\sigma_{t,\, t+\Delta t}}{\sqrt{\sigma_t}\ \sqrt{\sigma_{t+\Delta t}}} , \tag{160}$$

where the correlation is calculated between the observation at time t and at t + Δt later.

To correct for this over or under estimation of the true correlation, the correlations can be combined using the Fisher Z' transformation. The serial correlation for each of the 4 years is first converted to a Fisher Z' transformation. A weighted mean of the four Z' transformations is then converted back to a serial correlation. The applicable form of the Fisher Z' transformation is (Brooks and Carruthers, 1953):

$$Z' = .5\ [\ln (1 + r) - \ln (1 - r)]. \tag{161}$$

The transformation has two convenient properties which will be useful later. First, the transformation has a nearly normal distribution with a mean of:

$$\mu_z = 0.5 \ln \left(\frac{1 + \rho}{1 - \rho}\right), \tag{162}$$

and second, the transformation has a standard error of:

$$\sigma_z = 1 / \sqrt{N - 3} . \tag{163}$$

The goodness of these approximations increases with small absolute values of ρ and with larger sample size of N.

The individual transformations are weighted according to their contributions to the 4 years of data with the weights being proportional to $1 / \sigma_z^2$; i.e., to N - 3. The weighted Z' transformations are then combined into a total Z' transformation (Brooks and Carruthers, 1953),

$$Z' = [(N_1 - 3)\ Z_1' + (N_2 - 3)\ Z_2' + (N_3 - 3)\ Z_3' + (N_4 - 3)\ Z_4'\ ] \ /\ \Sigma\ (N_i - 3)\ . \tag{164}$$

N_i and Z_i' are the number of observations and the Fisher Z' transformations for the years $i = 1, 2, 3, 4$ respectively.

For transformation back to correlation space,

$$r = \frac{\exp\ (2Z) - 1}{\exp\ (2Z) + 1}\ . \tag{165}$$

The inverse Fisher Z'-transformation can also be expressed in the form of the hyperbolic tangent. Multiplying the numerator and denominator of equation (165) by e^{-Z} gives:

$$r = \frac{e^{Z} - e^{-Z}}{e^{Z} + e^{-Z}} \tag{166}$$

$$= \mathrm{Tanh}\ (Z')\ .$$

Figures 20 and 21 show the serial correlations for the January visual extinction and July temperature. The correlations use the 50 observation pad between the months. The decay for the visual extinction is fairly smooth, while the temperature decay shows a rise at 24 and 48 hours. Since the correlations are of equivalent normal deviates instead of the raw variables, most of the diurnal change should have been removed during transnormalization. The temperature correlation rise at 24 and 48 hours is most likely due to strong synoptic controls; e.g., frontal systems, cloud cover. Any OPAQUE variable containing temperature exhibited a similar rise. For example, the equivalent IR aerosol extinction shows a similar rise at 24 and 48 hours since temperature is used in calculation of the extinction. Therefore, computation of the decay function includes serial correlations only out to 24 hours.

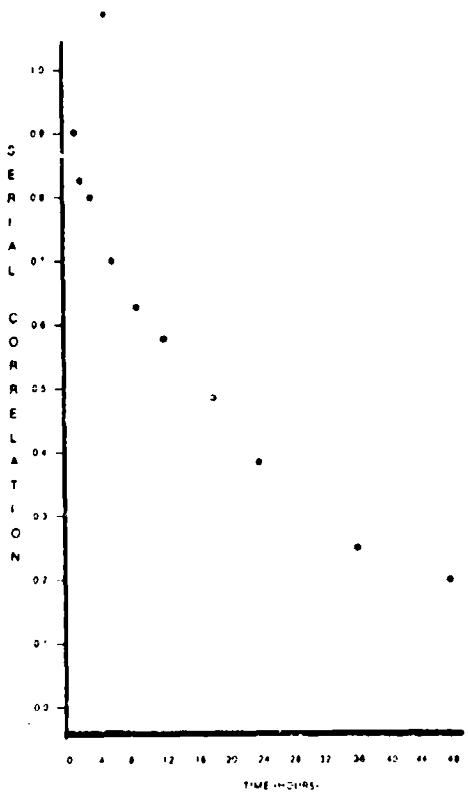

Figure 20. Serial Decay for the Ypenburg January Visual Extinction.

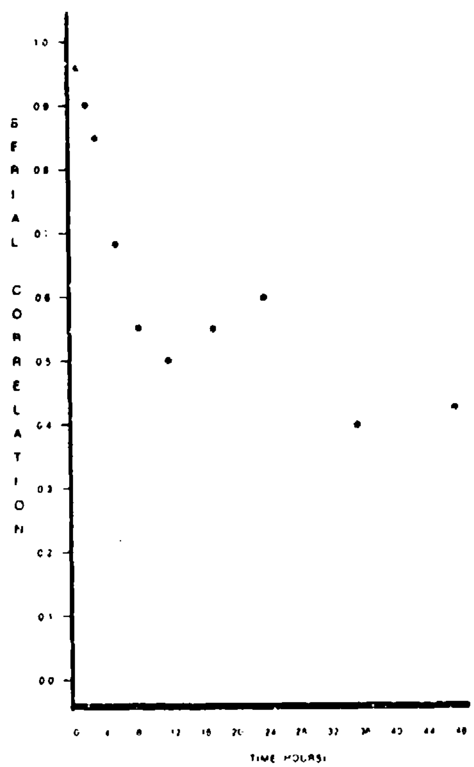

Figure 21. Serial Decay for the Ypenburg July Temperature.

Tables 12 and 13 contain the same serial correlation based on the 50 observation pad as Figures 20 and 21. In addition, the table includes the correlations for each separate year and the number of observations used as a weighting factor. Finally, the table gives the serial correlation based on the weighted Fisher Z' transformation. The first combination technique tends to be fairly close to the weighted Fisher Z' transformation for time lags less than 3 hours, but the Fisher Z' transformation is definitely better as time lags increase.

TABLE 12. Serial Correlation for Ypenburg January Visual Extinction (km^{-1}).

	HR 1	HR 2	HR 3	HR 6	HR 9	HR 12	HR 18	HR 24
OVERALL	.8992	.8366	.7958	.6944	.6231	.5823	.4717	.3728
YEAR 1	.8990	.8517	.8115	.6987	.5775	.4977	.3616	.2681
WF	703	700	696	687	681	675	666	661
YEAR 2	.8669	.8011	.7356	.6374	.5658	.5070	.3553	.2402
WF	717	714	714	710	707	705	699	693
YEAR 3	.9031	.8299	.7796	.6538	.5449	.4940	.3291	.2215
WF	714	712	710	704	698	692	680	668
YEAR 4	.8556	.7995	.7624	.6430	.5876	.5638	.4748	.3565
WF	716	715	714	711	711	708	705	693
FISHZ	.8827	.8216	.7735	.6586	.5692	.5165	.3823	.2729

TABLE 13. Serial Correlation for July Ypenburg Temperature (°C).

	HR 1	HR 2	HR 3	HR 6	HR 9	HR 12	HR 18	HR 24
OVERALL	.9614	.9088	.8526	.6860	.5600	.5064	.5612	.5984
YEAR 1	.9548	.8972	.8401	.6684	.5714	.5412	.5397	.5406
WF	743	742	741	738	735	732	726	720
YEAR 2	.9445	.8700	.7890	.5432	.3408	.3002	.4333	.4212
WF	617	614	611	601	592	583	565	547
YEAR 3	.9493	.8789	.8014	.5227	.3881	.2957	.3830	.4841
WF	741	740	739	736	733	730	724	718
YEAR 4	.9680	.9215	.8706	.7222	.6072	.5380	.5982	.6428
WF	716	714	712	706	700	694	682	670
FISHZ	.9554	.8944	.8293	.6351	.4904	.4315	.4950	.5313

5.4.3 Correction for Random Error of Observation. By assuming a first-order Markov model that has observation error, the measured serial correlation can be expressed as the product of the total random error correlation and the actual correlation at time lag t,

$$\rho(t) = \rho_e^{\,2}\,\rho^t \ . \tag{167}$$

The total serial correlation can be broken down into two terms involving the linear coefficients A and B. From equation (157b), $\rho(t)$ can be expressed in terms of the exponential regression coefficients A and B,

$$\rho\ (t) = \exp\ [A + Bt]\ . \tag{168}$$

Equation 165 can be readily solved for the coefficients A and B using standard regression techniques:

$$\ln\ \rho(t) = A + Bt \tag{169}$$

However, equation (166) minimizes the sum of the square of ln $\rho(t)$ rather than $\rho(t)$. To correct for this, a weighted linear technique, developed by Lt Col Pershing Hicks, Jr., (USAFETAC/DNY), modifies the least squares fit to minimize the error in $\rho(t)$ space:

$$\min \Sigma \left[\rho \left(\ln\rho - A - Bt\right)\right]^2 , \tag{170}$$

where the coefficients A and B are still determined by linear regression (see Appendix E).

The combined Fisher Z' serial correlations for the eight time lag periods are the inputs to the linear regression scheme. Appendix G contains the serial correlations for the individual years, all years combined, the Fisher Z combination, and the straight linear regression. Appendix H contains the A and B regression coefficients for each meteorological and electro-optical variable. Table 14 contains the root-mean-square (RMS) difference between the observed and model distributions for the 10m wind speed and relative humidity. The 10m wind speed represents the lowest and relative humidity the highest RMS values for the nine variables modeled. The size of the A and B coefficients have no relationship to the RMS value or the amount of observation error associated with the variable.

TABLE 14. Linear Regression RMS (%) Difference Between the Observed and Modeled Distribution for Random Error of Ypenburg 10m Wind Speed and Relative Humidity. The Modeled Distribution Assumes a First-Order Markov Process that has Observation Error.

	10M WINDSP	RH		10M WINDSP	RH
JAN	0.96	3.11	JUL	2.46	19.07
FEB	0.65	1.64	AUG	0.83	16.87
MAR	0.61	7.45	SEP	3.53	13.91
APR	3.25	.85	OCT	0.65	8.11
MAY	4.18	13.61	NOV	2.09	7.09
JUN	7.02	16.01	DEC	2.58	4.74

Not surprisingly, the variables with the least error in observation generally show the least improvement in serial correlation. Table 15 shows the January visual extinction and the July temperature examples previously used. Nevertheless, these improvements are significant. From modeling efforts associated with previous projects, the 1-hour serial correlation should be near .945 for visibility (equivalent to visual extinction) and .980 for temperature. For temperature, this compares with the .955, .873, and .968 obtained by the Fisher Z' combination, the linear regression, and the linear regression plus correction for observation error (exp B) respectively. Likewise, for visual extinction, the values for these three calculations are .883, .865, and .952 respectively. While the Fisher Z' combination compares favorably with the exp B and the expected 1-hour temperature serial correlations, the exp B 1-hour serial correlation for visual extinction is clearly better. For other variables subject to larger random error of observation, the exp B provides a superior model over the Fisher Z' combination and the standard linear regression model.

TABLE 15. Serial Correlation Regression Coefficients for the Ypenburg January Visual Extinction and July Temperature.

JANUARY VISUAL EXTINCTION

	HR 1	HR 2	HR 3	HR 6	HR 9	HR 12	HR 18	HR 24
FISHZ	.8827	.8216	.7735	.6586	.5692	.5165	.3823	.2729
REGRESSION	.8648	.8230	.7833	.6751	.5819	.5015	.3715	.2768

A = -.0957 exp A = .9087
B = -.0495 exp B = .9517

JULY TEMPERATURE

	HR 1	HR 2	HR 3	HR 6	HR 9	HR 12	HR 18	HR 24
FISHZ	.9554	.8944	.8293	.6351	.4904	.4315	.4950	.5313
REGRESSION	.8733	.8453	.8183	.7422	.6732	.6106	.5023	.4132

A = -0.1030 exp A = .9022
B = -0.0325 exp B = .9680

The one hour equivalent aerosol IR extinction linear regression serial correlation varies considerably. In the 3.4-5.0 micron band, values range from a low of .431 for June to a high of .756 for October. The .756 correlation is far below the expected values of .900 - .980. By comparison, the June and October exp B values are .885 and .928 respectively. For the 8.0 - 12.0 micro band, values range from a low of .482 for August to high of .680 for February. The corresponding exp B values are .935 and .905 for August and February respectively. The separation of the linear regression into a coefficient of error of observation and a coefficient of actual correlation is again the superior model.

5.4.4 **Yearly, Monthly, and Seasonal Correlation.** With the assumptions that each observation contains random error and the corrected serial correlation follows a first-order Markov exponential decay, the total serial correlation can be expressed as the sum of two linear regression coefficients A and B (equation 168),

$$\rho(t) = \exp[A + Bt].$$

Coefficient A represents the serial correlation due to random error of observation while coefficient B represents the corrected (with random error of observation removed) serial correlation. The sum A + Bt is the coefficient for the total measured serial correlation. Applying the coefficients A and B to β in equation (A-5) of Appendix A, where ρ_1 is the correlation at unit time, gives the serial correlation for each coefficient,

$$\rho = (e^{-\beta})^{n\Delta t} \tag{171}$$

$$= \rho_1^{\,n\Delta t}. \tag{172}$$

Equation (172) provides the monthly values for the serial correlation for each of the EO/Met variables.

There are three serial correlation options available for the EO/Met simulator: monthly, seasonal, and yearly. The monthly serial correlation option allows 12 exponential decays for each EO/Met variable. The seasonal option combines three months of serial correlations using the weighted Fisher Z-transformation similar to equation (164). For continuity with other analyses of the OPAQUE data, the winter season uses the December, January, and February data. The spring, summer, and fall seasons follow accordingly. The yearly serial correlation again uses the weighted Fisher Z-transformation to combine the 12 months of serial correlations. The weighting factors are the number of observations in the one hour serial decay. The 90 percent confidence level of each correlation is used to test the applicability of each option as a serial correlation model.

If the population correlation of each variable is ρ and the sample correlation is r, then 90 percent of the sample correlation coefficients drawn from the population will fall between the 90 percent confidence limits of ρ. Thus, from a single value of r within these limits, one can infer only a 10 percent risk of error that the population correlation is ρ. More precisely, there is only a 10 percent risk that r is not significantly different from ρ. To apply the confidence levels to the sample correlation, the correlation coefficients must be corrected for sampling variability.

The ENDs generated from the raw variables have a normal distribution. However, the distribution of the correlation of two variables, whether a cross or serial correlation, generally is not normal. The distribution of the sample correlation coefficient r does approach normality as the sample size increases. This approach to normality depends not only on sample size but on the value of the population correlation ρ. If the samples are drawn from a population for which $\rho = 0$, the distribution approaches normality rather slowly as the sample size increases. If the samples are from a population for which $\rho \neq 0$, the distribution is very skewed. When ρ is greater than zero, the skewness tends toward the left with high values being relatively more probable than lower values. The skewness is reversed for ρ less than zero. This complicated dependency of the sampling distribution of r on the value of ρ makes it impossible to employ the normal distribution directly. The Fisher Z-transformation (equation (161)), originally developed for a bivariate normal population, converts the sample correlation to a nearly normal distribution.

If the sample correlation coefficient r is computed from independent data, the statistic Z has a mean μ_Z and standard deviation σ_Z,

$$\mu_Z = .5 \ln \frac{1 + \rho}{1 - \rho}, \quad \sigma_Z = \sqrt{1/(N-3)}. \tag{173}$$

However, the observations of each variable are not independent, that is, the observations are correlated ($\rho \neq 0$). Equation (60) of the AWS Guide for Applied Climatology provides a correction for the serial dependency in the time series of observations:

$$N' = N \left(\frac{1-\rho}{1+\rho}\right), \qquad (174)$$

where N' is the effective number of independent observations in a sample size N. The standard deviation in equation (173) becomes:

$$\sigma_z = \sqrt{1/(N'-e)}. \qquad (175)$$

The 90 percent confidence limits in Z are:

$$Z_U = Z + 1.6448\ \sigma_z \qquad (176)$$

$$Z_L = Z - 1.6448\ \sigma_z. \qquad (177)$$

The inverse Z-transformation (Tanh(Z)) converts the confidence limits in Z-space to the confidence limits in ρ space (equation (166)).

Figure 22 shows the monthly, seasonal, and yearly serial correlations and 90 percent confidence levels in Z transformation space for visual extinction. The visual extinction plots have the most orderly monthly changes of any of the EO/Met variables. The confidence intervals become progressively smaller for the seasons and the year, as can be seen from equation (175). The effective number of observations N' for January, the winter season and the years are 70, 82, and 826 respectively. The yearly 90 percent confidence interval contains at least some portion of the 90 percent monthly intervals, although several months are borderline cases.

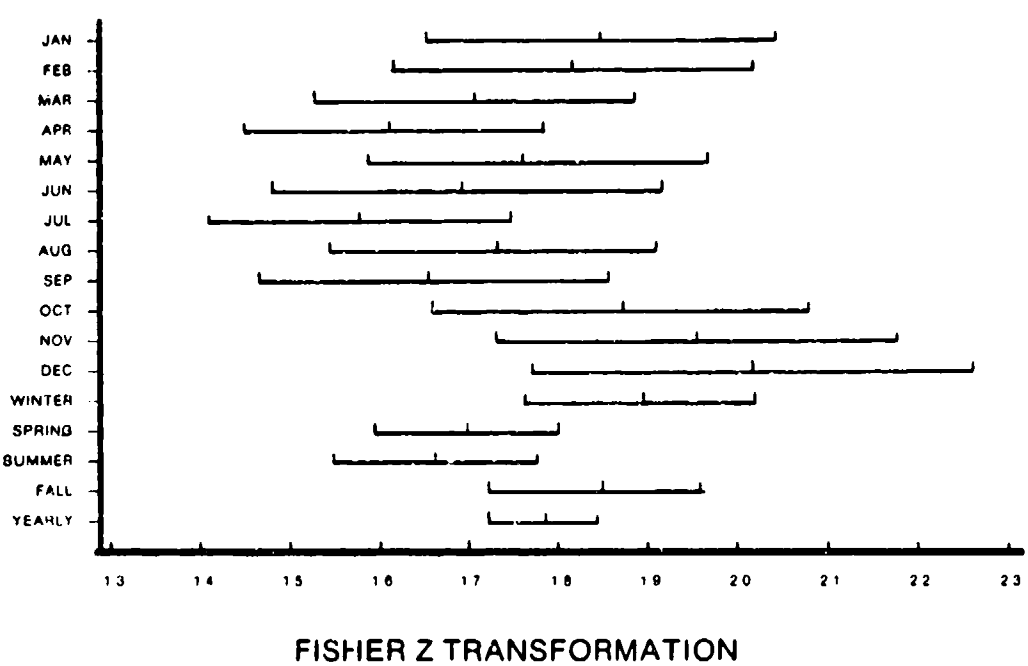

Figure 22. Monthly, Seasonal, and Yearly Serial Correlations and the 90 Percent Confidence Limits in Z'-Transformation Space for the Ypenburg Visual Extinction.

Figure 23 shows the monthly, seasonal, and yearly serial correlations and the 90 percent confidence levels in Z-transformation space for temperature. The month-to-month temperature pattern has the most erratic changes of any EO/Met variable. The 90 percent yearly confidence limit completely misses April and just barely touches the 90 percent lower confidence limit of two other months. In addition, the yearly serial correlation combines the weighted average of high and low extremes, thus misrepresenting the monthly values.

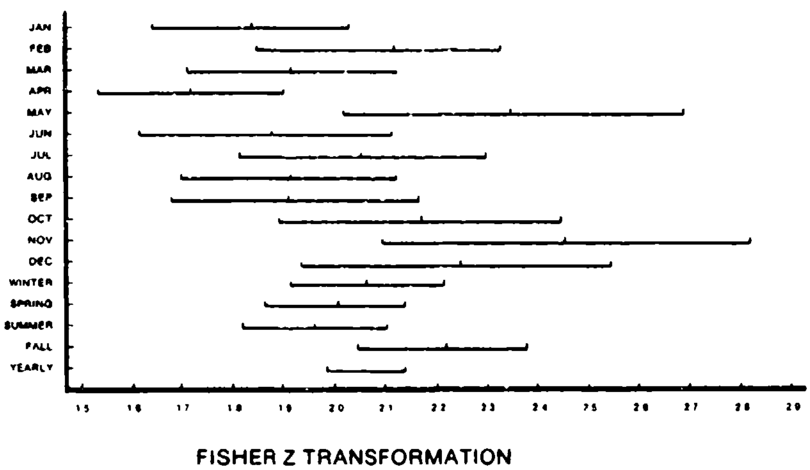

Figure 23. Monthly, Seasonal, and Yearly Serial Correlations and the 90 Percent Confidence Limits in Z'-Transformation Space for the Ypenburg Temperature.

Figure 24 shows the monthly, seasonal, and yearly serial correlations and the 90 percent confidence levels in the Z-transformation space for the aerosol equivalent IR extinction (8.0-12.0 micron band). The monthly pattern is between the smooth transition of visual extinction and the fluctuating pattern of temperature. However, March still misses the yearly 90 percent upper confidence limit. With the seasonal option, April definitely does not fit in the same pattern as the other spring months. If the data base were considerably longer than 4 years, this outlier might not exist. This particular problem points out the deficiency in using the monthly values of serial correlation. The small number of years in the data base may be responsible for the large changes in the monthly ranges. Both the seasonal and yearly options provide better estimates of serial correlation than the monthly option. Therefore, both the seasonal and yearly option will be available for the EO/Met simulator.

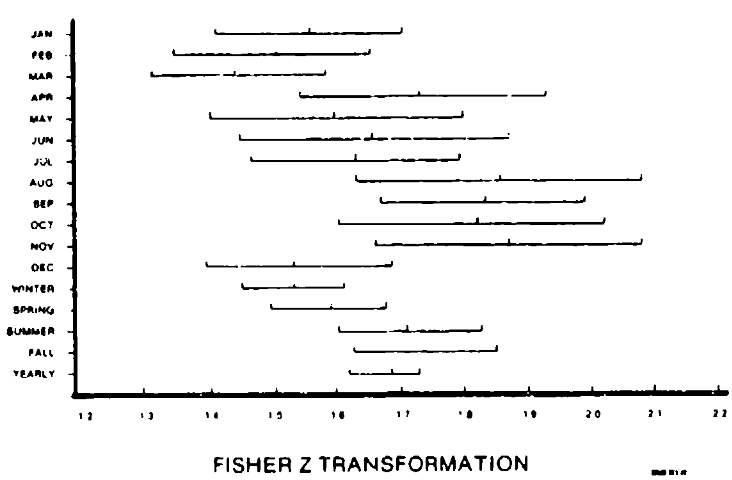

Figure 24. Monthly, Seasonal, and Yearly Serial Correlation and the 90 Percent Confidence Limits in Z'-Transformation Space for the Ypenburg Equivalent Aerosol IR Extinction 8.0 to 12.0 Microns.

5.5 Cross Correlation.

5.5.1 **Simulated Distributions of Cross Correlations.** The correction for random error of observation can also be applied to the cross correlation of two EO/Met variables. Assuming the Markov model exponential decay, equation (167) can be written:

$$\rho_m(t) = \rho_{ex}\, \rho_{ey}\, \rho_c^{\ t} , \tag{178}$$

where ρ_m is the measured serial correlation, ρ_c is the serial correlation corrected for random error of observation, and ρ_{ex}, ρ_{ey} are the correlations of random error for the variables X and Y respectively. Then the corrected serial correlation at time t can be expressed as:

$$\rho_c^{\ t} = \frac{\rho_m(t)}{\rho_{ex}\, \rho_{ey}} . \tag{179}$$

Equation (179) involves the product and quotient of normal random variables. This is more complicated than the multiplication case of the serial correlation. If X and Y represent the two normal random variables, then Z is the product or quotient of two normal random variables:

$$Z = XY \qquad \text{and} \qquad Z = \frac{Y}{X} . \tag{180}$$

In general, the resulting joint probability density function $f_z(Z)$ is not a normal distribution. Furthermore, the joint probability density function (PDF) resulting from the second mathematical operation has relatively little chance of having a normal distribution.

The product case in equation (180) is very similar to the serial correlation in Section 5.4.4, where the distribution of the sample correlation r is skewed to the left or right, depending on the sign of r. R. A. Fisher developed the Z-transformation (equation (161)) for a bivariate normal distribution to correct this skewness to a nearly normal distribution. Equation (174) involves three random variables rather than the two of the serial correlation correction. The mathematical solution for the multivariate case is to solve the product and quotient portions separately.

Meyer (1975) presents PDFs for the products and quotients of random variables. If X and Y are the two random variables with a joint PDF of f_{xy} such that $Z = g(X,Y)$, then the cumulative distribution function $F_z(z)$ is:

$$F_z(z) = \iint f_{xy}(X,Y)\, dx\, dy , \tag{181}$$

where the integration is in the X-Y plane with $g(X,Y) < Z$. For the case of the ratio of two random variables $Z = X/Y$, the joint PDF f_z is:

$$f_z = \int_{-\infty}^{\infty} f_{xy} \frac{|x|}{x^2} f_{xy} \left(x, \frac{x}{z}\right) dx \tag{182a}$$

$$= \int_{-\infty}^{\infty} f_{xy} \, |y| \, f_{xy} \, (yz, y)\, dy . \tag{182b}$$

For the product of two random variables $Z = XY$, the joint PDF is:

$$f_z = \int_{-\infty}^{\infty} f_{xy} \left(x, \frac{z}{x}\right) \frac{1}{|x|}\, dx \tag{183a}$$

$$= \int_{-\infty}^{\infty} f_{xy} \left(\frac{z}{y}, y\right) \frac{1}{|y|}\, dy . \tag{183b}$$

If the random variables X and Y are statistically independent with known probability densities, then equations (182) and (183) can be evaluated. For the independent normal random variables X and Y which are

distributed [0,1] and have PDFs of:

$$f_x(x) = \frac{1}{\sqrt{2\pi}} \exp\left(-\frac{x^2}{2}\right) \tag{184a}$$

$$4_y(y) = \frac{1}{\sqrt{2\pi}} \exp\left(-\frac{y^2}{2}\right) , \tag{184b}$$

respectively, Davenport (1970) gives the joint PDF for quotient Z=Y/X as:

$$f_z(z) = \frac{1}{\pi(1 + z^2)} . \tag{185}$$

Equation (185) is the Cauchy distribution, which has a mean but an indefinite standard deviation. The multiplication case cannot by analytically solved. An alternate method is to separate equation (179) into two quotients,

$$\rho_c^t = \frac{\rho_m(t)}{\rho_{ex}} \cdot \frac{1}{\rho_{ey}} . \tag{186}$$

The resultant ρ_c^t is the product of two Cauchy distributions, which again cannot be analytically solved.

The best approach at this point is to simulate the distribution of equation (179). The simulated distribution uses the general form of the normal equation,

$$\ddot{x} = \frac{X - M}{SD} , \tag{187}$$

where X is the normal deviate, $\ddot{x}$ is a generated random normal number distributed [0,1], SD is the simulated standard deviation, and M is the simulated mean. The distribution simulator generates a normal deviate X for each correlation using Equation (186), with the three X values being input to equation (179).

The initial values for the simulated distribution model are the measured cross correl 'ons between two variables ρ_{ex}, ρ_{ey}. The simulated means M_i are the correlations converted to Fisher _ space using equation (161), wh..e the simulated standard deviations SD_i follow from equation (163). Since dependency exists in each term of equation (179), the simulated standard deviation must be converted to the effective number of observations N' using equation (174). USAFETAC subroutine RANDBM generates three random normal numbers distributed [0,1]. The three simulated normal deviates X_i are combined in Z-space into a simulated ρ_c using equation (179). Equation (166) allows allows conversion to correlation space. This process is repeated a sufficiently large number of times to converge on the actual correlation.

5.5.2 **Correction for Random Error of Observation.** The correction term for random error of observation, when applied to the cross correlations, can be significant. However, quantitative estimates of the actual correlation can be made only if the random errors are entirely independent of each other and of the variables X and Y. The terms involving these errors are assumed to be zero for the independent case, but will increase ρ_c if the random errors are correlated with each other or with the variable themselves (see Appendix E). The corrected correlation of two highly dependent variables, e.g., aerosol equivalent IR extinction for the 3.4 to 5.0 and 8.0 to 12.0 micron bands, will give a cross correlation greater than one. Under the test conditions these error terms could be determined and the corrected cross correlation calculated. Therefore, the correction for random errors of observation can be applied only to those variables whose random errors are entirely independent from each other and from the variables X and Y.

For cross correlations between variables whose sensors are entirely different, the independent assumption is a good one. Temperature versus 10m wind speed and visual extinction versus humidity are two cases where the cross correlation can be improved. The random errors are not correlated with each other or the opposing variable. Even though the 10m and 2m winds both measure wind speed, measurements are from two separate anemometers, so the independent assumption still applies. Problems arise when a single instrument takes several measurements such as the case with the IR sensor. A second type of observation, where the random errors are not independent, occurs when one variable is derived from another variable, as is the case of the equivalent aerosol IR extinction. This variable uses temperature, moisture, and the IR transmission as inputs. A similar case occurs with the dewpoint, which is derived from the measured

relative humidity. Therefore, the correction for random error of observation can only apply to the cross correlation for combinations of: visual extinction, temperature, 10m wind speed, humidity, and 2m wind speed.

Simulated distributions for the corrected cross correlation ρ_c^t (equation (179)) were developed for each of the above cross correlation combinations during January and July using runs of 10,000 and 100,000 replications. The simulated means of all ρ_c^t's were then compared with the straight forward numerical solution of equation (179). Most of the means converge by 10,000 replications. Those that do not are with 3 percent of the numerical result. As pointed out previously, the exact solution of equation (179) involves the product of the Cauchy distribution, which has an indefinite standard deviation, with another unknown distribution. The outliers in the tail of the Cauchy distribution tend to have a strong influence in the mean of the resultant distribution for a small number of replications. As the number of of replications decreases, the difference between the simulated mean and the analytical result becomes larger. At 5,000 replications, the difference in the two results is as large 15 percent for some cross correlations.

Figure 25 shows the simulated distribution for the January visual extinction and 10m wind speed using 10,000 replications. Input serial correlations for visual extinction and the 10m wind speed are .9087 and .8781, respectively. The cross correlation for the two variables is -.3921. The simulated distribution for 100,000 replications is similar. However, the means are almost identical (-.4934 versus -.4932 for 100,000 replications). The general shape of the distribution follows the normal. However, the final distribution involves the product of two Cauchy distributions, so the standard deviation is indefinite.

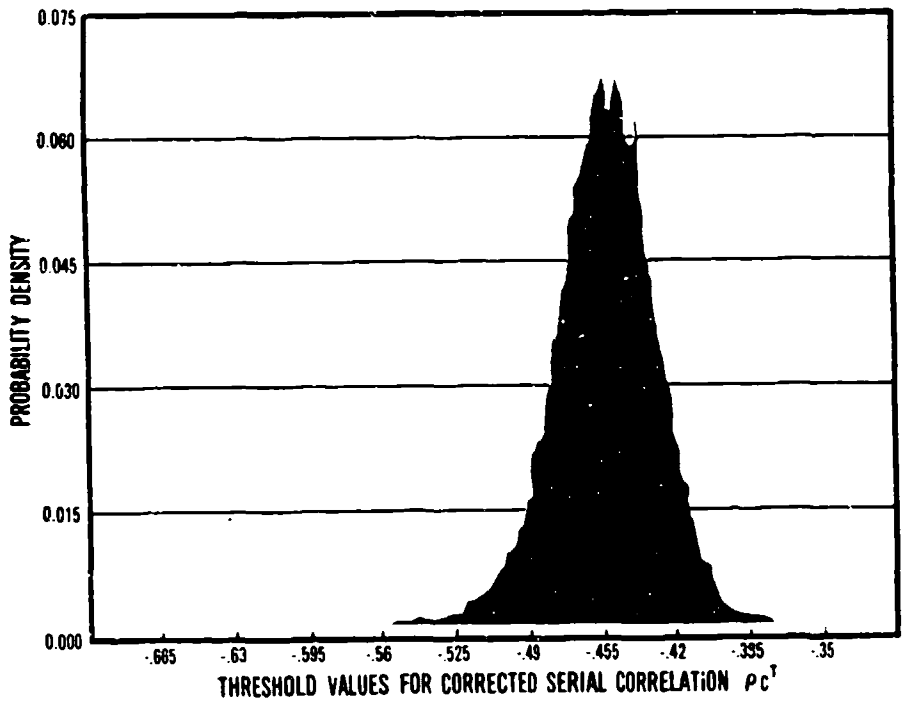

Figure 25. Simulated Ypenburg January Visual Extinction and 10m Wind Speed Using 10,000 Replications.

As expected, the cross correlations of those variables that are subject to the most measurement error improve the most when the correction for random error of observation is applied. Improvement is as high as 25 percent, but generally is in the 10-15 percent range. Table 16 shows the raw (R) and corrected (C) cross correlation matrix for January. The matrix ridge shows the relative error of each variable. Temperature and relative humidity observations have low random error of observation, so the raw correlation is high. Visual extinction, 10m wind speed, and 2m wind speed have more random error of observation, therefore the corrected cross correlation improvement is greater.

TABLE 16. Ypenburg January Cross Correlation Matrix for Random Error of Observation. R is the raw matrix and C is the corrected matrix.

		VIS EXT	10m WNDSP	2m WNDSP	TEMP	HUMIDITY
VIS EXT	R	.8257	-.3921	-.4262	-.1294	-.6900
	C	1.0000	-.4931	-.5201	-.1456	-.7812
10M WNDSP	R	-.3921	.7710	.5912	.0678	.3384
	C	-.4913	1.0000	.7475	.0789	.3968
2M WNDSP	R	-.4262	.5912	.8112	.0622	.3389
	C	-.5208	.7475	1.0000	.0706	.3872
TEMP	R	-.1294	.0678	.0622	.9564	.1161
	C	-.1456	.0789	.0706	1.0000	.1221
HUMIDITY	R	-.6900	.3384	.3389	.1161	.9446
	C	-.7812	.3966	.3872	.1221	1.0000

Based on analyses of the simulated distributions for January and July, the numerical solution to equation (179) can serve as the cross correlation corrected for random error of observation. This procedure applies only to those correlations for which the random errors of observation of each variable are independent of each other and of the opposing variable. The applicable variables are visual extinction, 10m wind speed, 2m wind speed, temperature and relative humidity. Appendix H gives the cross correlation matrix for each month.

CHAPTER 6

THE ELECTRO-OPTICAL/METEOROLOGICAL SIMULATOR

6.1 General. The Electro-Optical/Meteorological (EO/Met) simulator uses the USAFETAC Multivariate Triangular Matrix (MULTRI) Model, which allows for two distinct modeling efforts.

- Simulation of a single EO/Met variable and at some initial time and at N lag times (EOMETS1).
- Simulation of N EO/Met variables at a time lag Δt in which the cross correlations between the N EO/Met variables are preserved (EOMETS2).

The first model is best suited for building probability tables or simulating a single EO/Met variable for N time lags, while the second model is ideal for simulating from 1 to N EO/Met variables from user-supplied initial conditions where the cross correlations between the N variables are to be preserved.

Two important assumptions must be met in order to apply the EO/Met variables to the MULTRI model. First, the marginal distributions of the EO/Met variables must be adequately described by some transnormalizing function. All the EO/Met variables were successfully modeled in Chapter 4. Second, the serial correlation must reasonably fit the Markov decay function. With the model assumptions for error of observation in Chapter 5, the serial correlations follow a Markov decay. Thus the second assumption is satisfied. The ultimate test of the simulation models is how well the MULTRI model produces observations that are representative of the actual conditions.

Both models are quite similar in methods used to generate observations. The main difference is the technique used for constructing the correlation matrix. The EOMETS1 model uses the serial correlation matrix while the EOMETS2 model uses the cross correlation matrix. Chapter 3 covers the mathematics of the MULTRI model, so only the simulation will be discussed in this chapter. Table 17 shows the overall flow of the simulation model.

TABLE 17. Steps in Generating a Random Vector of N Correlated Elements of EO/Met Variables.

1. Build a correlation matrix $\underline{R}$ using an appropriate correlation model; i.e., the exponential decay model or the cross correlation model.

2. Obtain the lower triangular matrix $\underline{C}$ from $\underline{R}$ using the Cholesky Reduction Scheme (USAFETAC subroutine LUSQRT).

3. Generate N independent standard normal numbers ($\mu_1, \mu_2, \ldots \mu_n$) using USAFETAC subroutine RANDN.

4. Perform the matrix-vector multiplication using the theorem from Anderson (Whiton, 1982) using USAFETAC RANCV:

$$\underline{X} = \underline{C}\ \underline{\mu}$$

5. Transform each of the elements of $\underline{X}$ into values of the actual EO/Met variable using an appropriate trans-normalizing function.

6 2 Correlation Matrix. Paragraph 3.6 presented a theorem for the generation of a random vector $\underline{X}$ ($\underline{X} = \underline{C} \cdot \underline{\eta}$,), where η is a vector of random numbers distributed N(0,1) and $\underline{C}$ is a unique lower triangular matrix such that the correlation matrix $\underline{R}$ is equal to the product of $\underline{C}$ and the transpose of $\underline{C}$ (designated C'). That is, $\underline{R} = \underline{C}\ \underline{C}'$

The matrix $\underline{R}$ is ultimately used to generate the vectors of ENDs.

One method of deriving $\underline{C}$ from $\underline{R}$ is the Cholesky or "Square-root" method presented in Paragraph 3.6. Two requirements for this method are that the matrix $\underline{R}$ be real, symmetric and positive definite. If the symmetric positive definite requirements are not adhered to, the Cholesky algorithm will breakdown by

calling for division by zero or attempting to take the square root of a negative number. Symmetry is assured before the matrix R is passed to the algorithms, while the program containing the algorithm checks for the positive, definite requirement. All of the matrices met the positive, definite requirement.

6.3 EOMETS1 Model.

6.3.1 Model Requirements. The EOMETS1 model is the USAFETAC simulation model that produces observations of a selected EO/Met variable for an initial time and N time lags. Marginal distribution tables for the EO/Met variable can be developed as an extension of the model. The user supplies the EO/Met variable to be modelod, the initial hour and month of the simulation, the serial correlation of the modeled EO/Met parameter, the number of replications to perform, and the array of time lags for each replication.

If there is a requirement for marginal distribution tables at the completion of the simulation, the inverse transnormalizing functions for each of the EO/Met variables should also be available. The user indicates the lag time for the distribution table. Since the modeling coefficients for the transnormalizing functions are arranged by month and hour (i.e., coefficients are stored in a 12 x 24 array), the inverse transnormalization from an END to a value of the EO/Met variable being simulated is quick and efficient. The tabulating routine for the raw counts of the EO/Met variable use the same bin values as those used in building the cumulative distribution functions in Chapter 4.

6.3.2 Model Generation. The EOMETS1 simulator produces a single random vector of N correlated elements distributed N(0,1). Thus the elements can represent values for the ENDs of an EO/Met variable at an initial specified time and at N+1 time lags later. The simulation can be repeated any number of times, generating a series of independent random vectors. Each vector is independent of every other vector ($\rho=0$). Again, it is the elements within the vector that are correlated. If desired, marginal distribution tables can be developed from the series of random vectors. Table 17 summarizes the required steps for generating a random vector of N correlated elements of EO/Met variables.

The following simulation demonstrates the EOMETS1 model. We want to generate a marginal distribution table for the Ypenburg 3.4--5.0 micron equivalent IR aerosol extinction for March, beginning at 0200 MST. Lagtimes supplied to the model are 1, 2, 3, 6, 9, and 12 hours. The total serial correlation for March is .6425, while the serial correlation corrected for random error of observation is .9080. The corrected spring season serial correlation is .9057. The corrected spring season serial correlation, which from Chapter 5 is the serial correlation to be applied to the simulation model, is .9057. The USAFETAC subroutine RCALCT then uses equation (172) to generate the correlation coefficient between an initial time and at a time lag Δt later,

$$r_{\Delta t} = .9057^{\Delta t}.$$

For example, the 2- and 9-hour time lag observations are 7 hours apart and are related by the expression,

$$r_{\Delta t} = .9057^{7} = .50.$$

The complete time lag array is:

Lag Time

		0	1	2	3	6	9	12
L								
a	0	1.00	.91	.82	.74	.55	.41	.31
g	1	.91	1.00	.91	.82	.61	.55	.34
	2	.82	.91	1.00	.91	.67	.50	.37
T	3	.74	.82	.91	1.00	.74	.55	.41
i	6	.55	.61	.67	.74	1.00	.74	.55
m	9	.41	.45	.50	.55	.74	1.00	.74
e	12	.31	.34	.37	.41	.55	.74	1.00

The correlation matrix $\underline{R}$:

$$\underline{R} = \begin{matrix} 1.00 & .90 & .81 & .73 & .54 & .39 & .29 \\ .90 & 1.00 & .90 & .81 & .59 & .44 & .32 \\ .81 & .90 & 1.00 & .90 & .66 & .48 & .35 \\ .73 & .81 & .90 & 1.00 & .73 & .54 & .39 \\ .54 & .59 & .66 & .73 & 1.00 & .73 & .54 \\ .39 & .44 & .48 & .54 & .73 & 1.00 & .73 \\ .29 & .32 & .35 & .39 & .54 & .73 & 1.00 \end{matrix}$$

is lower triangularized using USAFETAC subroutine LUSQRT, which implements the Cholesky decomposition scheme. The result is the lower triangular matrix $\underline{C}$,

$$\underline{C} = \begin{matrix} 1.00 & 0.00 & 0.00 & 0.00 & 0.00 & 0.00 & 0.00 \\ 0.90 & 0.43 & 0.00 & 0.00 & 0.00 & 0.00 & 0.00 \\ 0.81 & 0.39 & 0.43 & 0.00 & 0.00 & 0.00 & 0.00 \\ 0.73 & 0.35 & 0.39 & 0.43 & 0.00 & 0.00 & 0.00 \\ 0.54 & 0.26 & 0.29 & 0.32 & 0.68 & 0.00 & 0.00 \\ 0.39 & 0.19 & 0.21 & 0.23 & 0.50 & 0.68 & 0.00 \\ 0.29 & 0.14 & 0.15 & 0.17 & 0.37 & 0.50 & 0.68 \end{matrix}$$

The USAFETAC subroutine RANCV generates a vector η of independent random standard normal numbers, i.e., numbers that are distributed N(0,1), and performs the matrix-vector multiplication, $\underline{X} = \underline{C} \cdot \underline{\eta}$.

There are many random normal number generators that can be used. EOMETS1 uses the USAFETAC subroutine RANDN. An example of this vector of independent numbers is:

$\eta_1 = -1.5271120$ $\qquad \eta_5 = -0.7852087$
$\eta_2 = 0.9978030$ $\qquad \eta_6 = -0.9851797$
$\eta_3 = -0.2934361$ $\qquad \eta_7 = 1.9020348$
$\eta_4 = -1.1453924$

The resulting vector $\underline{X}$ is:

$X_1 = -1.5271120$ $\qquad X_5 = -1.5432749$
$X_2 = -0.9437819$ $\qquad X_6 = -1.8008451$
$X_3 = -0.9777121$ $\qquad X_7 = -0.0220470$
$X_4 = -1.3773511$

Since the elements of $\underline{X}$ are distributed N(0,1), they represent correlated ENDs of equivalent IR aerosol extinction. The ENDs are then transformed to values of extinction using the line segment transnormalizing function and the modeling coefficients for the time and month of the simulated observation. The inverse transnormalized values represent extinction per km,

VECTOR ELEMENT	EQUIVALENT IR EXTINCTION (PER KM)
S_1 (t initial)	-0.88950
S_2 (t + 1)	-0.06445
S_3 (t + 2)	-0.06487
S_4 (t + 3)	-0.08390
S_5 (t + 6)	-0.08906
S_6 (t + 9)	-0.09631
S_7 (t + 12)	-0.05041

6.3.3 **Model Performance.** The standard method of evaluating USAFETAC's simulation models is to generate joint probabilites of the observed and simulated observations for the initial time and a time Δt later. However, the serial correlation specific to the EOMETS1 model is not the actual correlation of the variable but rather the correlation corrected for random error of observation. Differences between the '· can give a general view of how the simulator reproduces the equivalent aerosol extinctions.

Five thousand simulated observations were generated for equivalent aerosol IR extinction (3.4--5.0 microns) for 0200 MST March. These simulated extinctions were then compared with the Ypenberg observed extinctions.

The maximum difference between the observed and simulated frequency for the initial condition was 2.4 percent. The RMS error at a time lag of 12 hours is 1.81 percent with a RESMAX of - 6.55 percent using line segment fitting. Some of the difference is due to the transformation of the first element of the vector $\underline{X}$ into raw values of equivalent aerosol extinction. The differences between observed and simulated data is well within the limits allowed by sampling theory.

6.4 EOMETS2 Model.

6.4.1 Model Requirements. The EOMETS2 model is the USAFETAC simulation model that produces observations for N EO/Met variables at a time lag Δt. The cross correlations between the N EO/Met variables will be preserved for each simulation replication. The user supplies the initial hour and month of the simulation, the number of replications to perform, and the option to convert the ENDs to raw variables after simulation step. An input source file contains the input EO/Met variables, the cross correlation matrix of the EO/Met variables, and the seasonal serial correlations for each EO/Met variable.

The modeling coefficients for the mathematical functions that describe the CDF of each EO/Met variable are stored in a 12 x 24 array. Transnormalization begins the simulation as each raw EO/Met variable is converted to an END. The inverse transnormalization process can occur after each time step or at a point specified by the user.

6.4.2 Model Generation. The EOMETS2 simulator produces a single random vector of N correlated elements distributed N(0,1) where each vector is independent of the next one ($\rho = 0$). Table 17 summarizes the required steps for generating a random vector of N correlated elements of EO/Met variables. The correlation matrix $\underline{R}$ for the EOMETS2 simulator is the user supplied cross correlation matrix for the N EO/Met variables. From this point the simulator proceeds exactly as the EOMETS1 model.

6.4.3 Model Performance. The EOMETS2 preserves both the cross correlation between the variables and the serial correlation for each variable. These are guaranteed by the mathematics of the model. The simulator correlation input is the cross correlation matrix that has been corrected for random observation error. Only the B regression coefficient from Equation (182) has been used for the serial decay.

6.5 Transportability of the EO/Met Simulator. The effective transfer of the EO/Met simulator from Ypenburg to another location such as Christchurch, UK, depends on three factors. First, the modeling coefficients for the cumulative distribution functions for each of the OPAQUE variables must be available. Second, the LOWTRAN coefficients for the Barnes transmissometer, used in calculating the transmission of water vapor and molecular transmission, must be known. Finally, the serial and cross correlations used in initializing the EO/Met simulator must be specified.

The unique climatology of each location provides all environmental simulation models with their link to "real weather." As each station's climatology is different, so will be the regression coefficients that model the station's climatological base. The particular mathematical function selected for modeling each EO/Met variable is easily transferable to other locations. While nature can occasionally behave in erratic fashion, the CDFs of her variables behave in a predictable manner.

LOWTRAN regression coefficients for the Barnes transmissometer have already been established for each of the OPAQUE sites in Table 5. Using the Ypenburg coefficients for the Christchurch calculations of water vapor and molecular transmission gives an error of 3 to 5 percent in the modeled CDFs for aerosol transmission and equivalent aerosol extinction. Application to a new site without modeled coefficients would have an unknown result. To be a truly transportable model, coefficients for each site should be established.

Changes in serial and cross correlation can have a substantial effect on simulation results. Where the raw data are not available, many meteorological variables have been assumed to follow a Markovian exponential decay,

$$\rho_{\Delta t} = \rho_1^{\ \Delta t} ,$$

with Δt = .945. While this has not been a severe problem to simulation modeling, the serial correlation does change from month to month. For example, the Ypenburg equivalent aerosol IR extinction (3.4 - 5.0 microns) one hour serial correlation ranges from a high of .9528 in November to a low of .8850 in June. The yearly weighted serial correlation is .9131. All these values depart from the traditional value of .945. Since each month's climatology for each station is a function of many variables, a universal decay is not appropriate. Likewise, transporting a set of serial decays from one station to another introduces an error in correlation between the elements of the vector $\underline{X}$ in equation (110).

CHAPTER 7

PREDICTIVE REGRESSION EQUATIONS FOR OPAQUE DATA

7.1 **General.** Predicting values of electro-optical variables from meteorological observations using statistical methods has had only marginal success. Court et al. (1982) used both simple and multiple regression equations to establish the best predictive equations for infrared visibility at time lags of 1 to 24 hours. Although the Court et al. regression was with a physical model which may contain significant error, the study does provide a first look at the predictive capabilities of an EO/Met forecast model. Their model was based on a US Navy algorithm that expresses infrared visibility (IRV) as a function of wind speed, moisture, precipitation, air temperature, pressure, and visual range. The predictive equations were of three types: a simple linear regression equation for IRV involving the three preceeding hourly observations of IRV, a multiple regression equation involving the weather variables, and a multiple regression equation involving various positive powers (.5 , 1, 1.5, 2, 3, 4, 5) of the weather variables.

Court et al. results show a simple predictive linear regression equation has limited capabilities up to 6 hours, and almost no capabilities for longer time periods. Table 18 shows the coefficients of determination (R^2) of IRV by the three methods for one sample period. For a 1-hour time lag, 62 percent of the variance can be explained by using the previous hour's IRV value in the predictive model. Using IRV values for the 3 previous hours can explain only 65 percent of the variance. Additionally, the infrared visibility can be predicted slightly better for any time period using a linear combination of weather variables rather than combining the variables into a IRV.

TABLE 18. Coefficients of Determination (R^2) for Prediction of Infrared Visibility (IRV in km) by Three Regression Methods, (after Court et al., 1982).

TIME LAG	SIMPLE	MULTIPLE	MULTIPLE EXPONENTIAL
1	.62	.65	.66
3	.47	.49	.50
6	.29	.32	.33
12	.14	.16	.16
24	.04	.04	.06

7.2 **Application to the OPAQUE Data.** The Ypenburg OPAQUE data was processed for regression analysis with the SAS statistical package. The SAS STEPWISE procedure provides five methods for evaluating independent variables for inclusion in a regression model: forward selection, backward elimination, stepwise, maximum R^2 improvement, and minimum R^2 improvement. The results of the five methods were very similar. This section contains only the results of the stepwise regression. Appendix J contains the stepwise coefficients of determination (R^2) for the dependent variables visual extinction and equivalent aerosol IR extinction for the 3.4-5.0 and 8.0-12.0 micron bands. The independent variables are relative humidity (RH), dewpoint (DP), temperature (T), 10m wind speed (10m) and 2m wind speed (2m). An F-statistic of .15 is necessary for entrance into the model.

Tables 19 and 20 show the coefficient of determination (R^2) for the January and July visual extinction and equivalent aerosol IR extinction. An F-statistic of .15 is necessary for entrance into the regression model. The stepwise procedure uses the ENDs of the variables rather than the raw variables. Approximately 50 percent or less of the variance of the dependent variables can be explained by the independent variables. This agrees with the results of Court et al. The R^2 values for visual extinction are consistently higher than those of the infrared variables. Additionally, the winter R^2 values are higher than the summer values. The remaining months also show this pattern.

TABLE 19. Coefficients of Determination (R^2) for Ypenburg January Visual Extinction and Equivalent Aerosol Infrared Extinction at the .15 Significance Level.

VISUAL EXTINCTION

R^2	Variable(s) Entered
.4918	RH
.5296	RH, 2m Wind
.5388	RH, 2m Wind, Temp
.5446	RH, 2m Wind, 10m Wind

EQUIVALENT AEROSOL INFRARED EXTINCTION 3.4 - 5.0 microns

R^2	Variable(s) Entered
.2940	RH
.3091	RH, Dewpt
.3147	Temp, RH, Dewpt
.3159	2m Wind, Temp, RH, Dewpt
.3169	10m Wind, Temp, RH, Dewpt

EQUIVALENT AEROSOL INFRARED EXTINCTION 8.0 - 12.0 microns

R^2	Variable(s) Entered
.1399	RH
.2041	RH, Dewpt
.2107	Temp, RH, Dewpt
.2177	2m Wind, Temp, RH, Dewpt

TABLE 20. Coefficients of Determination (R^2) for Ypenburg July Visual Extinction and Equivalent Aerosol Infrared extinction at the .15 Significance Level.

VISUAL EXTINCTION

R^2	Variable(s) Entered
.3216	Dewpt
.4463	RH, Dewpt
.4700	10m Wind, RH, Dewpt
.4853	10m Wind, Temp, RH, Dewpt

EQUIVALENT AEROSOL INFRARED EXTINCTION 3.4 - 5.0 microns

R^2	Variable(s) Entered
.1484	RH
.1606	Temp, RH
.1690	Temp, RH, Dewpt
.1710	10m Wind, Temp, RH, Dewpt

EQUIVALENT AEROSOL INFRARED EXTINCTION 8.0 - 12.0 microns

R^2	Variable(s) Entered
.1203	RH
.1627	RH, Dewpt
.1701	Temp, RH, Dewpt
.1731	10m Wind, Temp, RH, Dewpt

Several behavior patterns in Tables 19 and 20 deserve comment. Relative humidity is almost always the first predictor in the single regression model, indicating the importance of moisture in the transmission process. The dewpoint temperature is often the second variable added to the regression model. In the case of the July visual extinction, the addition of dewpoint temperature significantly increases R^2 values. However, this increase in R^2 probably is due to relative humidity being used in the algorithm to calculate dewpoint temperature (Paragraph 2.2). The R^2 values improve very little after the addition of the second variable. Thus, a two-parameter multiple regression equation would be most efficient. However, none of the models show sufficient R^2 value to warrant use in a prediction equation.

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APPENDIX A

SERIAL CORRELATION IN FIRST-ORDER MARKOV MODELS

A defining property of the Ornstein-Uhlenbeck process (Whiton, 1982) is that

$$\mathrm{Cov}\,[x_{T+\Delta t}, x_T] = \rho\sigma_{x_{T+\Delta t}} \cdot \sigma_{x_T} = \alpha e^{-\beta\Delta t}, \tag{A-1}$$

which equals ρ for x distributed N(0,1). Hence, for N(0,1) x,

$$\rho = \alpha e^{-\beta\Delta t}. \tag{A-2}$$

Applying the boundary condition that $\rho = 1$ when $\Delta t = 0$ gives the result $\alpha = 1$. So,

$$\rho = e^{-\beta\Delta t}. \tag{A-3}$$

If ρ_1 is defined as the correlation at unit time, where $\Delta t = 1$, then

$$\rho_1 = e^{-\beta} = \text{const.} \tag{A-4}$$

Consider ρ at n time steps, $n\Delta t$

$$\rho = e^{-\beta n\Delta t} = (e^{-\beta})^{n\Delta t} = \rho_1^{\,n\Delta t}, \tag{A-5}$$

which is the characteristic Markovian correlation decay equation.

APPENDIX B

WEIGHTED LINEAR REGRESSION LEAST SQUARES FIT

The equation of the straight line through a set of points can be represented as:

$$Y_i = B_0 + B_1 X_i + \varepsilon_i, \tag{B-1}$$

where ε_i is the increment by which an individual Y falls off the line. For a set of observation pairs (X,Y) Equation (B-1) can provide estimates b_0 and b_1 for B_0 and B_1 respectively,

$$\hat{Y}_i = b_0 + b_1 X_i, \tag{B-2}$$

where $\hat{Y}_i$ is the predicted value of Y for a given X_i. The sum of the squares of deviations from the true line is given by:

$$SSE = \Sigma\, \varepsilon_i^2 = \Sigma\,(\hat{Y}_i - Y_i)^2 = \Sigma\,(Y_i - b_0 - b_1 X_i)^2, \tag{B-3}$$

where the summations are from i=1 to N.

For an equation of the form (Weibull distribution):

$$Q = \exp\,(-\alpha\, x^{\beta}), \tag{B-4}$$

a linear form can be found by taking the natural logarithm of both sides twice,

$$\begin{aligned} \ln Q &= -\alpha\, x^{\beta} \\ \ln\,(-\ln Q) &= \ln\alpha + \beta \ln x\,. \end{aligned} \tag{B-5}$$

A straight line fit to the set of ordered pairs lnx, ln(-lnQ) gives estimates of α and β. However, this minimizes the quantity:

$$\Sigma(\ln(-\ln Q) - \ln(-\ln \hat{Q}))^2, \tag{B-6}$$

rather than $\Sigma(Q-\hat{Q})^2$ as required by equation (B-3).

The change in Q space can be related to the change in ln(-lnQ) space by taking the derivative of ln(-lnQ):

$$\frac{d}{dQ}\,(\ln(-\ln Q)) = \left(-\frac{1}{\ln Q}\right)\cdot\left(\frac{d}{dQ}\right)(-\ln Q))$$

$$= \left(-\frac{1}{\ln Q}\right)\cdot\left(-\frac{1}{Q}\right)$$

$$= \frac{1}{(Q\ln Q)}$$

$$dQ = (Q\ln Q)\cdot d(\ln(-\ln Q)). \tag{B-7}$$

To integrate equation (B-7), QlnQ must be treated as a constant. The error in Q space is therefore approximately QlnQ times the error in ln (-lnQ) space, and

$$\Sigma\,(Q-\hat{Q})^2 = \Sigma\,((Q\ln Q)^2 \cdot (\ln(-\ln Q) - \ln(-\ln\hat{Q}))^2). \tag{B-8}$$

Substituting equation (B-5) into equation (B-8) for the predicted Q term gives an expression for the sum of the squares of deviation:

$$\Sigma\,((Q\ln Q)^2 \cdot (\ln(-\ln Q) - \ln\alpha - \beta\ln x)^2). \tag{B-9}$$

Let $(Q\ln Q)^2$ be a weighting factor WF. Then equation (B-9) becomes:

$$\Sigma\,(WF \cdot (\ln(-\ln Q) - \ln\alpha - \beta\ln x)^2). \tag{B-10}$$

To determine the estimates of α and β, differentiate equation (B-10), first with respect to α and then with respect to β, and set the results to zero.

$$\frac{\partial SSE}{\partial\alpha} = \frac{\partial}{\partial\alpha}\,\Sigma\,(WF \cdot (\ln(-\ln Q) - \ln\alpha - \beta\ln x)^2) = -2\,\Sigma\,\frac{WF}{\alpha}\,(\ln(-\ln Q) - \ln\alpha - \beta\ln x) \tag{B-10a}$$

$$\frac{\partial SSE}{\partial\beta} = \frac{\partial}{\partial\beta}\,\Sigma\,(WF \cdot (\ln(-\ln Q) - \ln\alpha - \beta\ln x)^2) = -2\,\Sigma\,WF \cdot \ln x \cdot (\ln(-\ln Q) - \ln\alpha - \beta\ln x) \tag{B-10b}$$

Equating equations (B-10a) and (B-10b) to zero, we have:

$$-2\,\Sigma\,\frac{WF}{\alpha}\,(\ln(-\ln Q) - \ln\alpha - \beta\ln x) = 0$$

$$\ln\alpha\,\Sigma WF = \Sigma(\ln(-\ln Q) \cdot WF) - \beta\Sigma(\ln x \cdot WF) \tag{B-11a}$$

$$-2\,\Sigma(\ln x\,WF(\ln(-\ln Q) - \ln\alpha - \beta\ln x)) = 0$$

$$\beta\,\Sigma(\ln X^2 \quad F) = \Sigma(\ln X \cdot WF \cdot \ln(-\ln Q)) - \ln\alpha\,\Sigma(\ln X \cdot WF). \tag{B-11b}$$

Equations (B-11a and (B-11b) are the normal equations for a straight line linear regression fit. Equation (B-11a) can be solved for α by exponentiating both sides:

$$\alpha = \exp\left(\frac{\Sigma\,[WF\,\ln(-\ln Q)] - \beta\Sigma\,[WF \cdot \ln x]}{\Sigma WF}\right) \tag{B-12}$$

Substituting equation (B-11a) into equation (B-11b) for $\ln\alpha$ yields a similar expression for β:

$$\beta = \frac{\Sigma WF\,\Sigma[(\ln x)(\ln(-\ln Q))(WF)] - [\Sigma(WF\ln x)\,\Sigma((WF)\ln(-\ln Q))]}{\Sigma WF\,\Sigma((WF)(\ln x^2)) - (\Sigma WF\,\ln x)^2}. \tag{B-13}$$

Equations (B-12) and (B-13) are the estimates of α and β for a weighted linear regression least squares fit. Again the weighting factor WF is (QlnQ) .

APPENDIX C

YPENBURG MODELING COEFFICIENTS

GAMMA LOGNORMAL COEFFICIENTS FOR VISUAL ATTENUATION

HRS (MST)								
HRS (MST)	YPENBURG JANUARY							
1 - 8	0.24921155	0.24360144	0.15814883	0.22569150	0.22477698	0.23041373	0.28438693	0.29737115
9 - 16	0.33291882	0.32729048	0.39230788	0.34624904	0.38051540	0.40887219	0.34438270	0.31081074
17 - 24	0.31951672	0.29377788	0.15815926	0.25366074	0.22572470	0.20071453	0.22028261	0.13312566
HRS (MST)	YPENBURG FEBRUARY							
1 - 8	0.06085217	0.11798251	0.11607808	0.09038562	0.03297341	-0.04314363	-0.04706466	0.01216751
9 - 16	0.08491778	0.20541954	0.31901938	0.44412714	0.52486485	0.56656337	0.51621050	0.49136442
17 - 24	0.47905236	0.37994474	0.23152399	0.18234736	0.09715289	0.08240527	0.09252167	0.05160773
HRS (MST)	YPENBURG MARCH							
1 - 8	0.60192209	0.59960848	0.55071098	0.45753890	0.37709302	0.41508132	0.40236390	0.43075180
9 - 16	0.65682578	0.84501594	0.99068761	1.04030514	1.08592415	1.29866791	1.31897354	1.19605541
17 - 24	1.29009151	1.19350243	1.12083349	1.01753139	0.83457726	0.85613024	0.73791474	0.68632925
HRS (MST)	YPENBURG APRIL							
1 - 8	1.00331688	0.84029776	0.79928148	0.68245322	0.68388057	0.66789109	0.70828909	0.88545597
9 - 16	1.16816330	1.52138615	1.54429913	1.54866600	1.70701122	1.79584980	1.85242558	1.79484177
17 - 24	1.70503426	1.80962849	1.68004227	1.47954655	1.03591442	1.12898540	0.97956949	1.03795338
HRS (MST)	YPENBURG MAY							
1 - 8	0.81222343	0.73363048	0.64836776	0.56399584	0.52979320	0.63206893	0.73659509	0.87114173
9 - 16	1.13394642	1.47748756	1.57238293	1.73532963	1.84498596	1.95075703	1.91086674	1.70322895
17 - 24	1.66049671	1.60089970	1.67439556	1.53890514	1.25390339	1.09975815	0.92609513	0.84608698
HRS (MST)	YPENBURG JUNE							
1 - 8	0.79054451	0.70317602	0.58356363	0.39572471	0.48490471	0.47220910	0.65071756	0.82989359
9 - 16	0.91938484	1.22186661	1.16564846	1.59290314	1.83298111	1.81284809	1.71650410	1.76910609
17 - 24	1.97576523	1.96982098	1.76885986	1.54718781	1.43950653	0.97336954	0.90146995	0.80685854
HRS (MST)	YPENBURG JULY							
1 - 8	0.97874652	0.86087191	0.77405375	0.66673392	0.60971564	0.85876107	1.25443077	1.37952042
9 - 16	1.69187641	1.79983139	1.93441677	2.13465405	2.09640121	2.11626244	2.05960178	2.17474842
17 - 24	2.01991949	2.20263863	2.32549858	2.18272018	1.86146545	1.48770618	1.17704964	1.02580452
HRS (MST)	YPENBURG AUGUST							
1 - 8	0.40974420	0.39707834	0.39621162	0.31704330	0.31856191	0.36642599	0.51870984	0.77190298
9 - 16	1.04779339	1.47321224	1.49877262	1.60287476	1.76130962	2.11167717	2.05148792	1.93460083
17 - 24	1.75071335	1.63490582	1.39186478	1.11074829	0.92361844	0.68356913	0.52367359	0.44741344
HRS (MST)	YPENBURG SEPTEMBER							
1 - 8	0.53810400	0.50711513	0.43737191	0.41131711	0.39678478	0.39068913	0.38007563	0.49094844
9 - 16	0.74532455	1.01106358	1.24777412	1.41845894	1.44046021	1.58881283	1.80015659	1.73807812
17 - 24	1.59815407	1.35752201	1.14376354	0.97903961	0.88925004	0.75756866	0.69161552	0.65307552
HRS (MST)	YPENBURG OCTOBER							
1 - 8	0.08055699	0.12415254	0.00884449	-0.01580501	-0.02976012	-0.03567529	-0.03911775	0.06020033
9 - 16	0.27661842	0.39779520	0.52699751	0.61822075	0.70712841	0.75978816	0.72152513	0.68497574
17 - 24	0.49234569	0.48449695	0.33627039	0.15868431	0.16854703	0.11436224	0.13668036	0.03237468
HRS (MST)	YPENBURG NOVEMBER							
1 - 8	0.62911654	0.48859167	0.40946966	0.47131103	0.43191880	0.40467924	0.51214540	0.46768087
9 - 16	0.59070081	0.73871845	0.73386347	0.80128294	0.79664648	0.88297999	0.93926269	0.80537069
17 - 24	0.70940417	0.67816710	0.66262317	0.63501257	0.66661328	0.71888095	0.60930485	0.68274182
HRS (MST)	YPENBURG DECEMBER							
1 - 8	0.41574705	0.45205510	0.44686919	0.39331207	0.52672681	0.53992891	0.58340985	0.47866172
9 - 16	0.47735476	0.59508681	0.63946092	0.75570941	0.7799[illegible]98	0.71598244	0.81162435	0.67707372
17 - 24	0.66043109	0.61831456	0.66278392	0.63383454	0.55199432	0.55776316	0.41373026	0.38586485

ETA LOGNORMAL COEFFICIENTS FOR VISUAL ATTENUATION

HRS (MST)	YPENBURG JANUARY							
1 - 8	0.66326702	0.59455800	0.59023434	0.61383605	0.63791811	0.66862339	0.65852022	0.65737510
9 - 16	0.76934308	0.76659095	0.72276491	0.68396342	0.69043577	0.65603691	0.66618752	0.75113219
17 - 24	0.69733876	0.71119058	0.65814900	0.66453046	0.61465371	0.57815725	0.61039704	0.63547415
HRS (MST)	YPENBURG FEBRUARY							
1 - 8	0.88179731	0.82119256	0.79131699	0.77484691	0.75415373	0.70748067	0.75234467	0.74788231
9 - 16	0.75572938	0.87672621	0.91398305	1.03196335	0.96434546	0.98305637	0.97320135	0.96446508
17 - 24	1.02658367	1.00590611	0.83196253	0.80136424	0.82086682	0.86045164	0.86743283	0.88361096
HRS (MST)	YPENBURG MARCH							
1 - 8	0.79130906	0.75629824	0.73990136	0.70591772	0.70779091	0.78663975	0.82740581	0.83632863
9 - 16	0.78887814	0.92071265	0.98107481	0.94211525	0.94543314	1.14518642	1.13364506	1.04505444
17 - 24	1.08818150	1.01381111	1.00670910	1.06218815	0.95636338	0.97829485	0.91902536	0.82866067
HRS (MST)	YPENBURG APRIL							
1 - 8	0.92155445	0.86491662	0.81874877	0.82389826	0.81414968	0.78834552	0.78636575	0.79661751
9 - 16	0.91199815	1.10059357	1.11695194	1.05332851	1.11003304	1.12926483	1.15381241	1.16021347
17 - 24	1.09698009	1.11396217	1.07520103	1.02587605	0.78159189	0.97281605	0.86776209	0.90834320
HRS (MST)	YPENBURG MAY							
1 - 8	1.00945187	0.91087615	0.87458003	0.88531274	0.92565894	0.91142809	0.91142052	0.96591622
9 - 16	1.01610374	1.23306751	1.19280624	1.23913860	1.31106758	1.36273956	1.35006618	1.19185352
17 - 24	1.13705921	1.12729740	1.15940094	1.11032295	1.02435684	1.00736904	0.96250850	0.93659323
HRS (MST)	YPENBURG JUNE							
1 - 8	1.12747002	1.07950974	1.05391693	1.01119518	1.18494892	1.02007103	1.06835270	1.14840794
9 - 16	1.12330723	1.23205757	1.10551643	1.35056305	1.46465492	1.39065933	1.28296947	1.29670048
17 - 24	1.44166946	1.37229156	1.33862019	1.23681927	1.21488380	0.95340717	1.00884056	1.09237289
HRS (MST)	YPENBURG JULY							
1 - 8	0.94344532	0.86382818	0.88278705	0.87813109	0.83425504	0.96076977	1.16302586	1.11911392
9 - 16	1.30374050	1.27251911	1.32363224	1.42856216	1.35447121	1.30019188	1.27182865	1.34761620
17 - 24	1.23481369	1.39189911	1.53074932	1.48451042	1.34854984	1.18340302	1.03483105	0.93461847
HRS (MST)	YPENBURG AUGUST							
1 - 8	0.75195253	0.78532034	0.74565446	0.67478359	0.76126945	0.74904948	0.83510631	0.88353312
9 - 16	0.92133415	1.19411659	1.15596008	1.19685173	1.28479958	1.43041611	1.36855984	1.28217888
17 - 24	1.17832088	1.13800526	1.04110813	0.95541245	0.90808017	0.84047359	0.72822410	0.75136405
HRS (MST)	YPENBURG SEPTEMBER							
1 - 8	0.78882051	0.80141538	0.78253001	0.72368294	0.69446266	0.78796184	0.74387830	0.71563965
9 - 16	0.75583106	0.85276973	0.83716559	0.94605309	0.86897278	0.89546090	1.05646324	1.00074570
17 - 24	0.95610106	0.85294688	0.87294674	0.83389777	0.84178096	0.79357237	0.79227781	0.81328177
HRS (MST)	YPENBURG OCTOBER							
1 - 8	0.66635132	0.68060559	0.61777741	0.59862250	0.64532995	0.61246818	0.55757427	0.64549166
9 - 16	0.63989842	0.65286100	0.70114434	0.70539361	0.75671613	0.73202062	0.70913213	0.69332522
17 - 24	0.67316961	0.75561261	0.69285756	0.64944148	0.64441824	0.67289835	0.65825611	0.62711233
HRS (MST)	YPENBURG NOVEMBER							
1 - 8	0.66116899	0.59546107	0.59940553	0.61702293	0.53675318	0.64784080	0.73056048	0.66313624
9 - 16	0.66167068	0.67274457	0.68016559	0.67621195	0.66866076	0.63846153	0.66949159	0.62931913
17 - 24	0.63945448	0.65931988	0.63882238	0.64131504	0.70360309	0.70955384	0.73955679	0.73681813
HRS (MST)	YPENBURG DECEMBER							
1 - 8	0.71196592	0.71564043	0.67170036	0.66857266	0.69500631	0.70275748	0.76483572	0.79228102
9 - 16	0.82068390	0.74898762	0.80695033	0.78379279	0.81057084	0.76487964	0.82694840	0.76908500
17 - 24	0.77812928	0.71401954	0.72492456	0.72982544	0.70634776	0.71376598	0.68607891	0.65848207

GAMMA LOGNORMAL COEFFICIENTS FOR VISUAL EXTINCTION

HRS (MST)	YPENBURG JANUARY							
1 - 8	0.32713968	0.33960414	0.26822621	0.30058980	0.28103000	0.34457552	0.36638331	0.40612030
9 - 16	0.42180276	0.47920734	0.50806963	0.48257113	0.56220275	0.57726300	0.53368926	0.41239178
17 - 24	0.41096991	0.36369514	0.30866307	0.37632483	0.32681906	0.29618031	0.28659242	0.22650272

HRS (MST)	YPENBURG FEBRUARY							
1 - 8	0.25387317	0.26222056	0.27989358	0.24672514	0.23467916	0.13825840	0.18651187	0.24226409
9 - 16	0.29843038	0.45349580	0.52145904	0.70403939	0.77303505	0.75549787	0.68770248	0.70265120
17 - 24	0.63185805	0.53998649	0.39438164	0.38913417	0.27535194	0.23775065	0.24290395	0.22352868

HRS (MST)	YPENBURG MARCH							
1 - 8	0.64469004	0.59301138	0.55442822	0.58929795	0.48358047	0.53027630	0.56214696	0.63412905
9 - 16	0.86897969	0.98861212	1.10848808	1.45099831	1.51328850	1.36398602	1.59370899	1.46979618
17 - 24	1.36162376	1.35061932	1.40023804	1.09261227	0.93786204	0.94529867	0.80919117	0.69765109

HRS (MST)	YPENBURG APRIL							
1 - 8	1.00539303	0.92483789	0.89091474	0.71918392	0.72219408	0.86148053	0.86071754	1.06440449
9 - 16	1.44761181	1.46899700	1.57254124	1.44914722	1.84267235	2.32250786	2.19382191	2.26575184
17 - 24	2.08036137	2.05321789	1.84107971	1.58188057	1.17692947	1.21207142	1.04589272	1.10539913

HRS (MST)	YPENBURG MAY							
1 - 8	0.97962582	0.92809176	0.84232074	0.86518252	0.78104901	0.95789802	1.07691193	1.13761806
9 - 16	1.63998985	2.00292015	1.97646618	2.19020748	2.31562042	2.33916283	2.52536106	2.18430138
17 - 24	2.00577641	1.98201370	2.14578247	1.79856219	1.53710270	1.40675068	1.10354519	1.04471588

HRS (MST)	YPENBURG JUNE							
1 - 8	1.17066002	1.03443336	1.26202965	0.87690723	0.97507149	1.09630585	1.57688808	1.83536816
9 - 16	1.70153046	1.96674728	1.88896370	1.86085129	1.83780861	2.15346336	2.10787582	2.42197418
17 - 24	2.38761616	2.34105206	2.06047249	1.84117603	1.69739246	1.49150753	1.36829567	1.03304100

HRS (MST)	YPENBURG JULY							
1 - 8	1.12190819	1.00597382	0.87468010	0.79387629	0.78765595	1.31956005	1.55639458	1.77696228
9 - 16	2.25121021	2.31393528	2.67225266	2.70038986	2.58547688	2.68516827	2.45784283	2.52706909
17 - 24	2.50054836	2.48644257	2.36301613	2.36865139	2.13849068	1.60385513	1.26761532	1.18995380

HRS (MST)	YPENBURG AUGUST							
1 - 8	0.57821178	0.53044707	0.52825552	0.45010555	0.51851755	0.57706958	0.74860406	1.02845192
9 - 16	1.55206871	1.80918217	1.80179024	1.76058960	1.98265553	2.56917953	2.66852665	2.52441883
17 - 24	2.11091423	1.95303249	1.61042118	1.30115795	1.13373566	0.85770279	0.78655434	0.64987260

HRS (MST)	YPENBURG SEPTEMBER							
1 - 8	0.76445699	0.74511814	0.71107328	0.62624192	0.65066308	0.64792293	0.85893840	0.92456222
9 - 16	1.33040714	1.52574348	2.01970005	2.14360332	1.95351696	1.89964390	2.26016617	2.14243317
17 - 24	1.95208645	1.59019184	1.27907658	1.11387634	1.63978374	0.85200238	0.88387549	0.86575168

HRS (MST)	YPENBURG OCTOBER							
1 - 8	0.22190911	0.26211292	0.20139062	0.23041081	0.18985373	0.18900597	0.15736192	0.40400243
9 - 16	0.62075043	0.70989567	0.88417423	0.99815494	1.05523682	1.22205544	1.10295582	1.01158810
17 - 24	0.72885096	0.66817486	0.49231964	0.32644832	0.33301401	0.28909343	0.28074968	0.14550638

HRS (MST)	YPENBURG NOVEMBER							
1 - 8	0.84173423	0.62661594	0.55374581	0.54894388	0.52543777	0.44912612	0.62209278	0.64826667
9 - 16	0.77453351	0.99731362	1.02165413	1.10679245	1.04597855	1.15870190	1.06257343	1.01193047
17 - 24	0.89341742	0.80682015	0.85180497	0.77198207	0.76469129	0.78573620	0.77142400	0.77249674

HRS (MST)	YPENBURG DECEMBER							
1 - 8	0.56662977	0.55212742	0.59932911	0.56162101	0.68470371	0.67262882	0.63895553	0.59024602
9 - 16	0.59400553	0.80788201	0.86972696	1.03074169	1.11522102	0.97996777	1.01218033	0.90884411
17 - 24	0.78450018	0.78141105	0.84415948	0.79302955	0.69559121	0.67602926	0.51793700	0.58163202

ETA LOGNORMAL COEFFICIENTS FOR VISUAL EXTINCTION

HRS (MST)	YPENBURG JANUARY							
1 - 8	0.79073465	0.75199413	0.73679304	0.72379053	0.71310878	0.81440783	0.80938566	0.82459688
9 - 16	0.85470307	0.83519667	0.81841576	0.77005315	0.81435633	0.83796585	0.90453500	0.84403062
17 - 24	0.83862203	0.82937831	0.82169366	0.79896379	0.73145419	0.76729864	0.72423059	0.75492990

HRS (MST)	YPENBURG FEBRUARY							
1 - 8	1.04727268	0.95390266	0.95073807	0.93711460	0.96763259	0.92632848	1.00363445	1.01480007
9 - 16	0.94117361	1.04716492	1.00142002	1.11799431	1.05315685	1.06890488	1.04212379	1.11288643
17 - 24	1.21429825	1.22479534	1.03892231	1.03950977	1.05611134	0.98971426	1.07115650	1.06937695

HRS (MST)	YPENBURG MARCH							
1 - 8	0.98747033	0.91330987	0.88054377	0.95944411	0.97388828	1.09436989	1.05052853	0.99239981
9 - 16	1.01776123	1.05289459	1.10497379	1.29201984	1.39296341	1.29289532	1.42240143	1.33230972
17 - 24	1.28067493	1.32084370	1.45668507	1.27862453	1.21783447	1.25369263	1.16932487	0.93960428

HRS (MST)	YPENBURG APRIL							
1 - 8	1.09483719	1.11798191	1.05168724	0.95874053	0.96978623	1.05260563	0.93658632	0.91503078
9 - 16	1.15518665	1.15098858	1.30694485	1.19086075	1.42062855	1.79256725	1.60432243	1.62253189
17 - 24	1.50787163	1.48178673	1.35623646	1.30600262	1.12976170	1.22095966	1.06980991	1.11596394

HRS (MST)	YPENBURG MAY							
1 - 8	1.15865898	1.09980392	1.04076004	1.08455944	1.01694393	1.05167580	0.98696357	1.05778503
9 - 16	1.39835072	1.65288067	1.61771679	1.82312298	1.88316727	1.95829391	2.07666397	1.72160053
17 - 24	1.58510971	1.54543877	1.75430298	1.57128620	1.43739223	1.34922981	1.15791035	1.19637966

HRS (MST)	YPENBURG JUNE							
1 - 8	1.33570671	1.28294182	1.45804501	1.24682617	1.32125854	1.23175621	1.48667526	1.67970276
9 - 16	1.62148190	1.72881508	1.79673958	1.88695049	1.88466644	1.99508953	1.93201160	2.04578400
17 - 24	1.92796230	1.76495361	1.69938087	1.51788902	1.50582981	1.35286331	1.39504433	1.21356487

HRS (MST)	YPENBURG JULY							
1 - 8	1.04527378	0.97810203	0.92182857	0.91433662	0.86542022	1.12364674	1.11435890	1.15381432
9 - 16	1.41900252	1.46382332	1.72727585	1.83095264	1.77188110	1.85546875	1.68517876	1.64590836
17 - 24	1.56911755	1.55654240	1.55551720	1.63474560	1.52377701	1.26323509	1.12014484	1.02604866

HRS (MST)	YPENBURG AUGUST							
1 - 8	0.92293531	0.93168253	0.91294420	0.83265656	1.01665211	0.95804429	1.63679752	1.09455681
9 - 16	1.32696438	1.43574905	1.48010254	1.52351284	1.61952591	1.89273357	1.98992157	1.84787655
17 - 24	1.57991409	1.55716801	1.35905838	1.31087399	1.21714973	1.06317043	1.06546211	0.95604169

HRS (MST)	YPENBURG SEPTEMBER							
1 - 8	1.08139133	1.08373737	1.06198788	1.02131081	1.05089951	1.05230713	1.15742302	1.00860214
9 - 16	1.13341141	1.17344379	1.39175606	1.48659611	1.34806442	1.32220354	1.57476139	1.54224682
17 - 24	1.47692108	1.35965443	1.29915428	1.17641640	1.12256908	1.03239059	1.09581280	1.12402344

HRS (MST)	YPENBURG OCTOBER							
1 - 8	0.79013491	0.80698764	0.78821522	0.76171935	0.81460351	0.77647662	0.70147026	0.84262127
9 - 16	0.81987149	0.80579549	0.85061342	0.86232966	0.88364422	0.93921435	0.94814092	0.96673971
17 - 24	0.92331123	0.90191627	0.85796690	0.76883703	0.81242353	0.79304957	0.75641811	0.85540611

HRS (MST)	YPENBURG NOVEMBER							
1 - 8	0.91868180	0.75079089	0.73900640	0.70604825	0.68691021	0.79049438	0.88000941	0.87379509
9 - 16	0.77900416	0.86910409	0.82918310	0.83365297	0.80720520	0.87842351	0.94211382	0.88592869
17 - 24	0.88974088	0.81666583	0.84136885	0.82565147	0.86434919	0.81219316	0.84366590	0.91588193

HRS (MST)	YPENBURG DECEMBER							
1 - 8	0.83043802	0.87988085	0.80658841	0.80711651	0.87599164	0.83469641	0.91912347	0.89737588
9 - 16	0.97862017	0.94599229	0.96772134	0.97220141	1.00470924	0.96971428	1.02028370	1.02042580
17 - 24	0.96677154	0.94396579	0.92641771	0.91912627	0.84567475	0.84158766	0.84401399	0.81765229

ALPHA LINE SEGMENT COEFF' 'TS FOR AEROSO' IR TRANSMISSION 3.4 - 5.0 MICRONS

HRS (MST)	YPENBURG JANUARY							
1 - 8	-1574355341	-1574813597	-1405857934	-1674819725	-1624360084	-1456062606	-1606857608	-1641134479
9 - 16	-1691206539	-1809758363	-1826738328	-1640742819	-1776472480	-1759432097	-1708968080	-1557315205
17 - 24	-1641332874	-1641528717	-1574029715	-1388952461	-1472772763	-1557311889	-1674556292	-1539879297
HRS (MST)	YPENBURG FEBRUARY							
1 - 8	-1607384734	-1641198484	-1675215001	-1910623389	-1725941414	-1540406413	-1607911320	-1522972553
9 - 16	-1422178443	-1658701214	-1641861547	-1776672192	-1776475085	-1793447093	-1775948477	-1860361146
17 - 24	-1826739884	-1809173925	-1624494247	-1692958021	-1691595914	-1725546129	-1708509583	-1624554903
HRS (MST)	YPENBURG MARCH							
1 - 8	-1808969313	-1691397745	-1606791270	-1607314544	-1540010095	-1589814373	-1623894620	-1572905585
9 - 16	-1725620286	-1810224546	-1927666613	-2012344002	-1961617586	-20[illegible]5296	-2079651002	-2012144051
17 - 24	-2062804401	-2029511580	-1978722440	-1945292415	-1978253441	-19[illegible]2209	-1961343590	-1859957100
HRS (MST)	YPENBURG APRIL							
1 - 8	-1860620439	-1843251326	-1860488076	-1725678211	-1792526473	-1792921482	-1827328661	-1793975212
9 - 16	-1844111293	-2029252034	-1970920893	-1962140095	-2063464147	-2029712863	-2029712863	-2063399915
17 - 24	-2062939600	-2046622903	-2029773011	-2012604564	-1945362051	-2012664217	-2012595581	-1995497107
HRS (MST)	YPENBURG MAY							
1 - 8	-1945294204	-1927919744	-1793575812	-1726595713	-1709755538	-1911483567	-1844437976	-1928390600
9 - 16	-2029252047	-2012736739	-2063334381	-2012474843	-2029319397	-2063282022	-2097151466	-2063267298
17 - 24	-2063398873	-2046555853	-2063265453	-1962006921	-1978911900	-2063128720	-1995821974	-1961482388
HRS (MST)	YPENBURG JUNE							
1 - 8	-1877331602	-1877329528	-1894498954	-1741930373	-1877922199	-2029447350	-1995760075	-2097148092
9 - 16	-2063264969	-2046554830	-2097082554	-2063133896	-1962077891	-2097146808	-2097149148	-2097149891
17 - 24	-2097150404	-2097151182	-1995761336	-2096818856	-2097015213	-2046220960	-2029112961	-1961805956
HRS (MST)	YPENBURG JULY							
1 - 8	-2012402822	-1893913732	-1809368703	-1944308868	-1877068177	-1995431070	-2012737485	-2046490588
9 - 16	-2063398624	-2079979984	-2063463902	-2046292139	-2096887259	-2080044514	-2080175072	-2063069910
17 - 24	-2096953297	-2080176338	-2029430928	-2063464100	-2097148310	-2097141640	-2046351507	-2029247372
HRS (MST)	YPENBURG AUGUST							
1 - 8	-1843772789	-1826600824	-1724955513	-1490401907	-1809427814	-1709359997	-1927993501	-1928190912
9 - 16	-2029777106	-2063200749	-2063399656	-2029384407	-2097085670	-2012871151	-2097151966	-2097086183
17 - 24	-2012804828	-2046424513	-2046423965	-2029773705	-2029772151	-2028917617	-2062992501	-1844359273
HRS (MST)	YPENBURG SEPTEMBER							
1 - 8	-1893646971	-1758969988	-1641332098	-1725413767	-1742454917	-1776141174	-1692453512	-2029645499
9 - 16	-2097149390	-1962275540	-2097151993	-2063334392	-2046359789	-2063400178	-2063399927	-2096954609
17 - 24	-2097151983	-2063465153	-2097147824	-2096819344	-2096551541	-1995424903	-1927791996	-1809759621
HRS (MST)	YPENBURG OCTOBER							
1 - 8	-1270394501	-1354870929	-1522511493	-1270055831	-1337965197	-1220719506	-1321249415	-1843713707
9 - 16	-1743446736	-1709431499	-1877137864	-1860953297	-1961551569	-2063004124	-1993763916	-2029512906
17 - 24	-1945098171	-1827197086	-1759232653	-1707848566	-1675015559	-1490074769	-1573173899	-1202893178
HRS (MST)	YPENBURG NOVEMBER							
1 - 8	-1674953636	-1540339359	-1523630483	-1254209426	-1304080785	-1085712008	-1270262411	-1472639366
9 - 16	-1658506160	-1726336955	-1743117750	-1777131731	-1810491079	-1827331275	-1810292674	-1995498168
17 - 24	-1978061480	-1810225080	-1961416362	-1658438565	-1842857378	-1658377383	-1792197282	-1759298474
HRS (MST)	YPENBURG DECEMBER							
1 - 8	-1456456103	-1624885394	-1405792918	-1355726212	-1490537113	-1490208148	-1540471934	-1674955916
9 - 16	-1691465863	-1776473499	-1708839080	-1911149481	-1944577978	-1809636524	-1962273936	-1843583635
17 - 24	-1792919181	-1657717137	-1792790440	-1708706461	-1674755736	-1472907423	-1383292741	-1439284891

BETA LINE SEGMENT COEFFICIENTS FOR AEROSOL IR TRANSMISSION 3.4 - 5.0 MICRONS

HRS (MST)	YPENBURG JANUARY							
1 - 8	1038151410	835576308	886501367	600369654	416145911	835904498	1071443189	1138682356
9 - 16	921369082	887549944	483980282	534769653	349564917	719122934	786560758	752742905
17 - 24	685502197	1005056503	987755258	1122232310	769715699	988279801	1122299126	1038215671
HRS (MST)	YPENBURG FEBRUARY							
1 - 8	450684918	399438074	315746292	432598520	467070200	886627825	970648056	919726838
9 - 16	953805816	836497400	231007735	12379640	-106177804	61986801	62447602	214102262
17 - 24	533852407	784852217	801825271	482797047	735375609	786099960	785507319	819258871
HRS (MST)	YPENBURG MARCH							
1 - 8	1391194104	1391522038	1441131510	1575349235	1508436980	1457645808	1525016564	1222238956
9 - 16	1070193135	1295461999	499374823	734385634	432658917	432264411	415751142	751817953
17 - 24	936369903	736698861	954196466	987686898	1171976440	1071376372	1289807347	1340534261
HRS (MST)	YPENBURG APRIL							
1 - 8	1190131704	1525867095	1526397690	1744107768	1744239354	1744501498	1811544825	988541433
9 - 16	954529018	534243574	365356788	466281199	-189278487	47242473	115271410	367784181
17 - 24	821096690	1391590138	1425340410	1308293882	1576729338	1509620474	1542781690	1575876600
HRS (MST)	YPENBURG MAY							
1 - 8	1054470133	121974007	1155854581	868933622	836231409	282121965	-72428565	-661012255
9 - 16	-360007198	[illegible]46273062	-747136817	-814832445	-746408758	-494030895	-962942517	-358758181
17 - 24	-206255382	[illegible]14102507	702014958	1239347446	832942584	1002694131	1037299449	986768371
HRS (MST)	YPENBURG JUNE							
1 - 8	1794636538	1794833146	1475082746	1744370426	1677392634	1559558138	820310005	501673716
9 - 16	46451939	-390278166	364629733	-21311264	279565297	399171306	-190328856	348578032
17 - 24	230679542	350747386	1056569850	1491924986	1492513066	1374352119	1526397690	1526201082
HRS (MST)	YPENBURG JULY							
1 - 8	1475934970	1560418042	1458960378	1643707130	1442511610	1207630586	551941113	-52958988
9 - 16	-306717714	-140062232	-577586214	-560349216	-627920417	-51041[illegible]15	-679100187	-240986389
17 - 24	163243767	165672697	1005385490	1274606378	1207499002	1325[illegible]98	1526397690	1274083065
HRS (MST)	YPENBURG AUGUST							
1 - 8	1643838202	1643379450	1878719226	1861810938	2029714170	1895496442	972420600	482733305
9 - 16	95804904	-475739923	-626474269	-595085597	-561796385	-559431446	-425868061	-172170512
17 - 24	231533305	484176890	1223490298	1526135546	1341323258	1311413754	1727396602	1794571002
HRS (MST)	YPENBURG SEPTEMBER							
1 - 8	1710750458	1609956099	1626733306	1627660986	1811610362	1777924344	1627060986	854849017
9 - 16	182383354	-307239691	-1063858191	-1266044192	-862467607	-1028798475	-827071754	-741872903
17 - 24	65075705	1122957306	1374812922	1660156666	1610086906	1256454906	1694038522	1525938682
HRS (MST)	YPENBURG OCTOBER							
1 - 8	986107857	886165969	750963403	650102473	750504651	750502344	632536770	447657141
9 - 16	10726316	-359817053	-510349907	-678519381	-662398030	-695624275	-359878986	10794165
17 - 24	482396360	750175685	650430921	901957320	498844611	801557451	768264906	986369742
HRS (MST)	YPENBURG NOVEMBER							
1 - 8	835182834	398978039	382526199	651553015	753136630	987227380	734979825	786228728
9 - 16	516875507	213771247	197120497	-307373674	-174012439	-206842654	314300388	583128548
17 - 24	500163053	299294444	213084274	365[illegible]74546	518058233	466480117	565628902	432790261
HRS (MST)	YPENBURG DECEMBER							
1 - 8	971569400	903606776	837986199	10721[illegible]35	937357561	1054995706	1005188090	1021636599
9 - 16	1089533177	887090425	1005449720	88748[illegible]78	685830392	954923514	1206316538	1273361145
17 - 24	1156642040	1022620665	1004989945	1055977976	1172828153	886827506	1021110518	988016375

ALPHA LINE SEGMENT COEFFICIENTS FOR AEROSOL IR TRANSMISSION 8.0 - 12.0 MICRONS

HRS (MST)	YPENBURG JANUARY							
1 - 8	-1675350430	-1624624825	-1691797934	-1827002560	-1675482563	-1591134643	-1792918443	-1709103036
9 - 16	-1860819649	-1894573516	-1827464146	-1759239102	-1827200204	-1793450953	-1827266500	-1709103276
17 - 24	-1726273441	-1742523818	-1760286639	-1692390575	-1709168064	-1641861546	-1793578155	-1742523812
HRS (MST)	YPENBURG FEBRUARY							
1 - 8	-1861082298	-1759633603	-1692851904	-1911478970	-1675809966	-1608240309	-1608178359	-1540737187
9 - 16	-1574622127	-1759760690	-1692260807	-1894440654	-1927732934	-1878055882	-1877203141	-1928256183
17 - 24	-1961878179	-1961547435	-1843648437	-1894702512	-1827000496	-1860620976	-1894308277	-1742919343
HRS (MST)	YPENBURG MARCH							
1 - 8	-1776011947	-1759367338	-1742258858	-1691731621	-1657977243	-1674557850	-1624294307	-1657851318
9 - 16	-1624165827	-1911154653	-1910825430	-1978592484	-2012212457	-2011949795	-2046029280	-2011686876
17 - 24	-2062281427	-2012014539	-1927865531	-1944904134	-2012405432	-1978652861	-1894439096	-1776082102
HRS (MST)	YPENBURG APRIL							
1 - 8	-1945293977	-1928452490	-1927992738	-1843711112	-1911213215	-1962271421	-1810294225	-1861284059
9 - 16	-1944905169	-2029713119	-1945103570	-1995896295	-2063202532	-1995896558	-2029582563	-2029450975
17 - 24	-2029712585	-2012935367	-2029773722	-2012930462	-1995825826	-2012274581	-2029641882	-2079842978
HRS (MST)	YPENBURG MAY							
1 - 8	-1995428968	-1944438361	-1826999141	-1759629187	-1743248782	-1894771412	-1793976544	-1911484119
9 - 16	-2046359267	-2046293745	-2063332849	-2063202550	-1996027382	-2063267830	-2097151997	-2063334387
17 - 24	-2029582564	-2012871119	-2097148071	-2029572753	-1978520208	-2079908224	-1945418875	-2045935971
HRS (MST)	YPENBURG JUNE							
1 - 8	-2012140935	-2012467318	-1844302747	-1962001824	-1878057896	-2029779667	-1961881054	-2097085408
9 - 16	-2046489568	-2097150694	-2097149668	-2062807275	-2046557177	-2097151982	-2046490614	-2097085430
17 - 24	-2046557173	-2097150698	-1995894481	-2097148108	-2097149631	-2063461278	-2046616218	-1995692704
HRS (MST)	YPENBURG JULY							
1 - 8	-2012599421	-1978385016	-1843184510	-1995358756	-1911281037	-1995368119	-2029449429	-2046490351
9 - 16	-2063399660	-2029582059	-2029516776	-2029252582	-2046491120	-2080111604	-2046424566	-2046359285
17 - 24	-2046491118	-2080242921	-2063200700	-2063464360	-2097146781	-2046614151	-2012665207	-2029178495
HRS (MST)	YPENBURG AUGUST							
1 - 8	-1928132628	-1927655784	-1894102618	-1742649698	-1909897050	-1860687492	-1860823493	-1928457433
9 - 16	-2063202797	-2097019640	-2097019386	-2063267573	-2097085693	-2096888566	-2097151486	-2097019643
17 - 24	-2063202794	-2080174545	-2029643936	-2046549107	-2063325571	-2097076835	-1996084827	-1979042163
HRS (MST)	YPENBURG SEPTEMBER							
1 - 8	-1944766344	-1961544861	-1910945673	-1894236804	-1911343250	-1978648980	-1861347784	-1945564908
9 - 16	-2063399411	-1996028145	-2063334396	-2097151224	-2063400179	-2063399156	-2063334395	-2097085689
17 - 24	-2097084651	-2063463867	-2097149354	-2097148826	-2063262095	-2096877947	-2012927366	-1961281400
HRS (MST)	YPENBURG OCTOBER							
1 - 8	-1503996659	-1422113132	-1725085799	-1270852983	-1456321135	-1456256117	-1473359718	-1961616554
9 - 16	-1625480630	-1692853693	-1995499720	-1928589526	-2029647311	-2063267797	-2029516755	-2063459259
17 - 24	-1894109075	-1961608581	-1927986038	-1725476970	-1759494753	-1540534117	-1674948967	-1590212722
HRS (MST)	YPENBURG NOVEMBER							
1 - 8	-1658178998	-1557708458	-1523961018	-1556857242	-1506784671	-1119726728	-1540472988	-1641729175
9 - 16	-1709560762	-1777131208	-1810751441	-1777134806	-1760094429	-1894442455	-1827135432	-1928653222
17 - 24	-1844502190	-1877992129	-1945103026	-1793380528	-1844107688	-1792924846	-1877267128	-1826804905
HRS (MST)	YPENBURG DECEMBER							
1 - 8	-1457115833	-1524421040	-1557185960	-1456785583	-1406387641	-1524155050	-1523564205	-1776733894
9 - 16	-1877069489	-1911613638	-1776541122	-1894312143	-2012081370	-1911481292	-2029381069	-1961351872
17 - 24	-1677268409	-1742258357	-1860819126	-1759565223	-1725419960	-1658506419	-1607976350	-1524224177

BETA LINE SEGMENT COEFFICIENTS FOR AEROSOL IR TRANSMISSION 8.0 - 12.0 MICRONS

HRS (MST)	YPENBURG JANUARY							
1 - 8	198565100	130733554	416343022	349034985	214556905	399037929	231923947	399696364
9 - 16	114288885	-87692303	-239608844	-307634954	-257567246	-207037192	-138809610	299493620
17 - 24	550102256	482795758	617338864	533849840	264692211	332391413	348577778	365615345
HRS (MST)	YPENBURG FEBRUARY							
1 - 8	28082.141	231137271	347922164	298311154	297394676	415295476	315289336	415952121
9 - 16	398319863	-105982736	-477057309	-578114070	-494490147	-511266075	-325664794	-173550352
17 - 24	432074485	399697913	432859123	398781169	903475958	416082421	483057398	164359673
HRS (MST)	YPENBURG MARCH							
1 - 8	583457255	499833568	550360034	650170594	566809312	498716894	197117909	78696925
9 - 16	-492917041	-780227127	-781015090	-1117479497	-1049779261	-1049386815	-1097483059	-762527012
17 - 24	-526406835	12046555	247844829	-37826335	280677091	281204451	297652704	3645[illegible]2911
HRS (MST)	YPENBURG APRIL							
1 - 8	854123554	1139274482	785901549	1021372401	702211312	433512687	129486822	-224410909
9 - 16	-426394406	-627786794	-527850295	-527646507	-662326062	-794771493	-560477722	-173945109
17 - 24	79092197	601349864	886564079	936897523	1139075826	635823602	1206184432	886762225
HRS (MST)	YPENBURG MAY							
1 - 8	1643377653	1559426039	1777859066	1575416309	1156050164	113957102	-324484388	-965174329
9 - 16	-730492988	-999914309	-1403488849	-1689615425	-1689157973	-1352559940	-1267496012	-1015437630
17 - 24	-426065178	448519152	818801388	1055322361	987688692	1257042937	1323102199	1173221113
HRS (MST)	YPENBURG JUNE							
1 - 8	1290728698	1374288122	1172960506	1189278969	1038416122	165209850	-357707796	-241644569
9 - 16	-4601[illegible]5447	-928991277	-1132815920	-1098275642	-1320249669	-1116361519	-1082546479	-1334010410
17 - 24	-846279961	-525085199	701561080	518320890	769453045	1038152698	1105260280	1088681210
HRS (MST)	YPENBURG JULY							
1 - 8	1828387578	1811413242	1693972474	1727593210	1374681850	1005058298	415490293	-542582806
9 - 16	-830233644	-1015178815	-1100117832	-1235450179	-1302430027	-1453621062	-1267821623	-963983898
17 - 24	-643573520	299824890	1274673914	1743977210	1643444986	1627060986	1761147642	1828190970
HRS (MST)	YPENBURG AUGUST							
1 - 8	1993831546	1928526586	2029452026	2029386490	1911945978	1677064186	701949943	-190267674
9 - 16	-829048359	-1302428227	-1639215937	-1371116893	-1707642719	-1588625746	-1386184247	-964253216
17 - 24	-241056792	180938226	1121840631	1610021370	1492318970	1593113338	1626339578	1811479290
HRS (MST)	YPENBURG SEPTEMBER							
1 - 8	1543043834	1341717242	1543174906	1408957178	1257962234	1341389562	888273658	-524489478
9 - 16	-878524687	-1571644206	-1858572870	-1808177246	-1488620879	-1773045825	-1571384113	-1349859609
17 - 24	-474624267	601353210	819653882	1324087802	972290041	1240726266	1291254522	1375271162
HRS (MST)	YPENBURG OCTOBER							
1 - 8	1492381114	1626340090	1525937914	1642855162	1542716154	1374942456	1542453240	1071640311
9 - 16	617933561	130145519	-256322324	-475869974	-610611741	-392379153	-70525448	736358906
17 - 24	1105984250	1425144570	1425405946	1694038522	1542845945	1626274554	1810954490	1727658746
HRS (MST)	YPENBURG NOVEMBER							
1 - 8	263178719	465295080	94946015	247120611	196988908	447661031	263636444	61522138
9 - 16	-326190897	-477059384	-494229572	-931686221	-746612813	-611936586	-173886014	-6051909
17 - 24	-5459000	-23086122	-375016493	120040415	-6505001	196067026	77705159	10924762
HRS (MST)	YPENBURG DECEMBER							
1 - 8	63567354	348908538	147256826	298973178	332067321	264761849	432533749	449702905
9 - 16	533456633	-21240070	-122164232	-256712454	-207299335	-335865350	-321980934	-52956422
17 - 24	685111546	517534458	-2560519	467004152	283636730	165082362	509626426	315879672

ALPHA LINE SEGMENT COEFFICIENTS FOR EQUIVALENT IR EXTINCTION 3.4 - 5.0 MICRONS

HRS (MST)	YPENBURG JANUARY							
1 - 8	-1824039544	-1622379885	-1857328504	-1688506750	-1637647220	-1689228664	-1841274244	-1791269247
9 - 16	-2000455036	-1941149562	-1788577392	-1839430251	-1788704619	-1873838949	-1890685053	-1857131649
17 - 24	-1839894142	-1942197119	-1908183672	-1808244348	-1840417900	-1958450039	-1858183297	-1824367752

HRS (MST)	YPENBURG FEBRUARY							
1 - 8	-1772256105	-1771601268	-1654225519	-1721401194	-1755020389	-1689556354	-1773899639	-1723570562
9 - 16	-1823971963	-1840287335	-1620078940	-1635608134	-1434275133	-1401121105	-1468032586	-1670017614
17 - 24	-1805484895	-1638698342	-1655736162	-1620934244	-1806276227	-1873711992	-1655477114	-1756533362

HRS (MST)	YPENBURG MARCH							
1 - 8	-1960035232	-1960033164	-1859567265	-1859962264	-1876670869	-1792523684	-1826276781	-1691071889
9 - 16	-1488955789	-1690893556	-1520269644	-1437692485	-1536719957	-1436055384	-1553691722	-1504281941
17 - 24	-1622378579	-1673106286	-1774095748	-1790746247	-1841605509	-1807920276	-1775284640	-1676014743

HRS (MST)	YPENBURG APRIL							
1 - 8	-2026609916	-2027664265	-2095422329	-2061811850	-2095688063	-2095756669	-2096213108	-1975616098
9 - 16	-1924951376	-1305937227	-1603759689	-1604217933	-1416909366	-1586136285	-1787774251	-1956922912
17 - 24	-1941857084	-2077726032	-2044108391	-2094439289	-2095101576	-2078056860	-2095035018	-2010754928

HRS (MST)	YPENBURG MAY							
1 - 8	-1840885391	-1891739014	-1891738497	-1672714624	-1706397050	-1553165917	-1383746865	-1113213759
9 - 16	-878925881	-643381027	-458567197	-491210025	-693646374	-795097633	-843524637	-1113999998
17 - 24	-1350192431	-1418814781	-1688961884	-1858840191	-1723108455	-1639228022	-1823974258	-1689625458

HRS (MST)	YPENBURG JUNE							
1 - 8	-2095755895	-2095760017	-2010948739	-2095625347	-2095623287	-2061932892	-1874616385	-1906862414
9 - 16	-1368021573	-1433355323	-1318612300	-1383946819	-1334408771	-1570400083	-1282950954	-1536324930
17 - 24	-1603101764	-2023448896	-2059762267	-1993713249	-2077533280	-1976606828	-2094772872	-2094837386

HRS (MST)	YPENBURG JULY							
1 - 8	-2077667719	-2045423236	-2061347974	-2095364228	-2094768250	-2093844848	-1940741952	-1703168815
9 - 16	-1500530220	-1265589564	-962413611	-1012874539	-894911786	-878724643	-928137000	-1282755126
17 - 24	-1569219128	-1938644023	-2025361753	-2093849446	-2094305397	-2094311292	-2095227511	-2010553973

HRS (MST)	YPENBURG AUGUST							
1 - 3	-2095560339	-2044706189	-2095761810	-2096088472	-2096617125	-2096349573	-2042336108	-1704881478
9 - 16	-1451449907	-1214985246	-1163541537	-861750834	-743851810	-1130445343	-1097218077	-1550994979
17 - 24	-1670272051	-1872849738	-2043126127	-2077929085	-2060628879	-2095305619	-2078656406	-2062272161

HRS (MST)	YPENBURG SEPTEMBER							
1 - 8	-2095560594	-2078324870	-2095299204	-2095686278	-2095952769	-2045558672	-2095360895	-2042329174
9 - 16	-1872056122	-1500464951	-1128407312	-859183891	-1111896861	-1246045724	-1532175125	-1717250584
17 - 24	-1938700573	-2026340943	-2060622430	-2078324092	-2095039381	-1959504771	-2095432328	-2077930875

HRS (MST)	YPENBURG OCTOBER							
1 - 8	-1287235205	-1337170033	-1219401344	-1168672878	-1152292214	-1085117049	-1000838016	-849851231
9 - 16	-646403895	-376590143	-543639618	-391725113	-358498872	-408305709	-577589565	-780621378
17 - 24	-1185312591	-1101632359	-1218875514	-1169663121	-1067878018	-1202428275	-1236114042	-1253942668

HRS (MST)	YPENBURG NOVEMBER							
1 - 8	-1622118502	-1704558701	-1654292343	-1738838389	-1890554998	-1689685568	-1655542140	-1773375366
9 - 16	-1688236634	-1502504014	-1401841483	-1249003321	-1131828802	-1265849149	-1435593031	-1453422155
17 - 24	-1621456228	-1637703251	-1787589220	-1737982816	-1873114727	-1721855584	-1335788135	-1570404194

HRS (MST)	YPENBURG DECEMBER							
1 - 8	-1975160674	-1857720692	-1890815603	-1908450687	-1891080306	-1925159289	-1908645263	-1908056189
9 - 16	-1992532867	-1857588591	-1958841441	-1891271520	-1856470350	-2025361250	-1892194403	-1909106041
17 - 24	-1992728446	-2026342524	-1891797857	-1992658796	-1909102966	-1773701739	-1790616449	-1891209580

BETA LINE SEGMENT COEFFICIENTS FOR EQUIVALENT IR EXTINCTION 3.4 - 5.0 MICRONS

HRS (MST)								
HRS (MST)	YPENBURG JANUARY							
1 - 8	767285739	750836709	464638182	699916528	750770412	599707368	582081008	733274091
9 - 16	616749297	616359665	936240883	784061681	953213938	885712114	801497073	549509358
17 - 24	566483691	666689001	851957993	699846885	683135209	464705774	481681138	397464560
HRS (MST)	YPENBURG FEBRUARY							
1 - 8	717150701	582410219	683597805	852225271	969270251	716822254	851566317	666358254
9 - 16	632605421	801628141	986700525	1356522225	1339614703	1171449586	1204674549	1339418358
17 - 24	1171384052	1036575221	1003150060	885055730	615702255	717021940	768007411	716954606
HRS (MST)	YPENBURG MARCH							
1 - 8	162784496	112254959	246405618	296671986	61790703	77714933	45014001	44487418
9 - 16	565829617	1003808762	1138352314	1491858170	1441067002	1323561978	1492252922	1306391802
17 - 24	1206319098	1122366969	904392954	467071481	533066744	416740602	147124472	180152307
HRS (MST)	YPENBURG APRIL							
1 - 8	936373492	533326068	684649463	767549679	667214325	768599284	785639922	1306585839
9 - 16	1357178872	1508504826	1424748793	1390538999	1710356730	1810953722	1760818681	1861810425
17 - 24	1659959034	1643640824	1256716282	1155920889	903802616	852424440	449771511	870380026
HRS (MST)	YPENBURG MAY							
1 - 8	752022516	499249911	617277679	365750762	701491178	1374088948	1524887278	1474752247
9 - 16	1575613689	1693054714	1979185145	1625945338	1810887418	1777530618	1878719226	1744107514
17 - 24	1727461114	1777530871	1391393018	853275383	713599417	953678586	1020459256	1121316600
HRS (MST)	YPENBURG JUNE							
1 - 8	885778673	566880759	650375158	703244212	953348084	1558247672	1390539770	1424832426
9 - 16	1508440314	1508964602	1291123450	1525217530	1592520954	1340734202	1660222202	1593178874
17 - 24	1576729338	1928723194	1407383031	1390034778	1407580922	1121647098	751958010	751367926
HRS (MST)	YPENBURG JULY							
1 - 8	802616314	751954170	432792311	751496952	818604792	1071575801	1609364727	1760818680
9 - 16	1861417208	1811085306	1760819706	1676473849	1643379450	1794243066	1743780090	1710094074
17 - 24	1760819706	1777727738	1542518009	1425209594	1190263546	752941818	987232762	685897210
HRS (MST)	YPENBURG AUGUST							
1 - 8	365358322	465234162	632806899	414701796	195815411	365552624	1037757940	1272639222
9 - 16	1609561847	1810883954	1912011002	1743517434	2029386490	2029385207	2113600250	1979251450
17 - 24	1811084538	1609758458	1324545274	887355128	668924666	668071674	583596794	280358899
HRS (MST)	YPENBURG SEPTEMBER							
1 - 3	650307575	566354425	532601592	582476018	649978354	582935545	835118316	1542191095
9 - 16	1492646650	1710092792	2113600250	2063071226	1928656634	2029517050	2012674298	1928919546
17 - 24	1979382522	1693906937	1609235194	1340472058	769260282	734394618	549974264	499376888
HRS (MST)	YPENBURG OCTOBER							
1 - 8	514377441	531679712	447336434	548914145	465028586	648988125	397002473	1154803962
9 - 16	1474356975	1373168110	1385929978	1507912696	1608577272	1827272440	1642853621	1474754295
17 - 24	1222308088	970058484	700703732	330489327	448258032	700372453	565825774	363773919
HRS (MST)	YPENBURG NOVEMBER							
1 - 8	935190517	766826219	708569578	599180773	531678694	396869077	430360041	464441322
9 - 16	969466090	1104078571	1272636651	1423960558	1507911408	1406920948	1406723316	1189278456
17 - 24	1053946360	1121380597	1204875770	935386613	784656629	919657456	868214010	1019208697
HRS (MST)	YPENBURG DECEMBER							
1 - 8	901764319	684317673	632541411	582733279	935975138	834786533	532468712	801562352
9 - 16	582475507	1076851829	1987234547	1154608886	1424222970	1372971770	1290399992	1079982394
17 - 24	684188665	784194293	1003414514	852156407	800774896	1002622955	363514093	884657382

ALPHA LINE SEGMENT COEFFICIENTS FOR EQUIVALENT IR EXTINCTION 8.0 - 12.0 MICRONS

HRS (MST)								
	YPENBURG JANUARY							
1 - 8	-1653434712	-1536254036	-1671587933	-1553817163	-1552965701	-1469674326	-1636922711	-1620929103
9 - 16	-1737185611	-1652381246	-1450462007	-1349538635	-1248940094	-1433687364	-1585011268	-1754950493
17 - 24	-1654426218	-1553565277	-1521120341	-1654813529	-1603430220	-1687255390	-1570467681	-1553495141
HRS (MST)	YPENBURG FEBRUARY							
1 - 8	-1603172173	-1620010828	-1536389702	-1603757651	-1502507868	-1637187681	-1771465050	-1737915234
9 - 16	-1536914269	-1333420631	-862082879	-811550266	-778065980	-811748922	-1063803712	-1316185168
17 - 24	-1721073765	-1738046046	-1704294485	-1654029917	-1857457240	-1704230487	-1654420818	-1787589214
HRS (MST)	YPENBURG MARCH							
1 - 8	-1504212321	-1503754848	-1503886940	-1353025120	-1436779887	-1335919467	-1301443172	-1334208085
9 - 16	-929516870	-692992558	-592395570	-322579237	-440673569	-491072293	-943469864	-1011760939
17 - 24	-1130253622	-1317166399	-1385391699	-1400855361	-1334931794	-1452501067	-1402302797	-1335128916
HRS (MST)	YPENBURG APRIL							
1 - 8	-1891403634	-1892066429	-1722909286	-1807851647	-1705543023	-1705076563	-1334403126	-1098269232
9 - 16	-963136824	-962410793	-643973177	-861880607	-709903140	-1062416665	-1096826664	-1182482990
17 - 24	-1485004093	-1655206213	-1740082030	-1756601191	-1824757096	-1823050358	-1841929070	-1773440877
HRS (MST)	YPENBURG MAY							
1 - 8	-2011154337	-1994377134	-2079048863	-1927001738	-1875028853	-1569545266	-1164658727	-524565039
9 - 16	-374683432	-172237850	-3086870	-1512976	48360944	-254745874	-288888333	-541272856
17 - 24	-1080375845	-1469281345	-1655671908	-1925224819	-1857528436	-1943117956	-1842197634	-1959371908
HRS (MST)	YPENBURG JUNE							
1 - 8	-2009964396	-1976808336	-1976209781	-1892369227	-1941671266	-1786995255	-1349272616	-1[illegible]81371942
9 - 16	-946226217	-927868964	-490612772	-608120089	-153754641	-624633630	-608313621	-624303379
17 - 24	-1095250964	-1465989914	-1822782262	-1906403900	-1840414021	-1908445799	-1874763104	-1925223781
HRS (MST)	YPENBURG JULY							
1 - 8	-2095891593	-2078985362	-2078849415	-2095435173	-2060497023	-2025947224	-1586913126	-1331704857
9 - 16	-676278555	-423963932	-272312354	-137701409	-53419799	-86450451	-305602066	-1061234197
17 - 24	-1347826972	-1989496609	-2094172749	-2061743456	-2078386030	-2095491970	-2096215697	-2095564166
HRS (MST)	YPENBURG AUGUST							
1 - 8	-2079708837	-2062341793	-2079579827	-2079774380	-2062409127	-2061677709	-1756066123	-1098141488
9 - 16	-978136607	-70588432	-102241549	332523501	367586551	31648749	-170986507	-725820426
17 - 24	-1181567520	-1653104185	-1841728624	-2061874072	-2061283206	-2061421473	-2044709034	-2095893646
HRS (MST)	YPENBURG SEPTEMBER							
1 - 8	-2094641532	-2094309221	-2095164033	-2094118018	-2093915255	-2094244977	-2025486659	-1700673822
9 - 16	-1213061879	-270339031	234223093	418377715	232515819	15592941	-304222477	-1009458957
17 - 24	-1365786145	-1789163345	-1840286300	-2009964908	-2025820798	-2093852558	-2094113919	-2060497556
HRS (MST)	YPENBURG OCTOBER							
1 - 8	-2094643861	-2044577432	-2027733919	-2044838538	-2061546647	-1993652628	-2010825892	-1841401439
9 - 16	-1722576219	-1518758220	-1399871554	-1180911412	-1113214521	-1130712624	-1601983035	-1940944220
17 - 24	-2009633143	-2077601411	-2061478550	-2078916508	-2027994791	-2027736474	-2045562013	-2095562395
HRS (MST)	YPENBURG NOVEMBER							
1 - 8	-1250977877	-1419803230	-1149787987	-1251048048	-1401650281	-1218216834	-1200847217	-1115912822
9 - 16	-879254351	-710890209	-627003447	-407452719	-408042537	-425608241	-880170815	-780562533
17 - 24	-981365336	-1031432518	-996891737	-1032090198	-981363808	-1083075929	-864447311	-1065512541
HRS (MST)	YPENBURG DECEMBER							
1 - 8	-1803968847	-1734819950	-1771006815	-1855417179	-1788242763	-1770942815	-1704752733	-1772314181
9 - 16	-1705146200	-1618826818	-1601722694	-1601131322	-1399868206	-1768706879	-1802392889	-1903913026
17 - 24	-1889894731	-1788574545	-1837066067	-1788835169	-1939238223	-1837854290	-1872919145	-1821995350

BETA LINE SEGMENT COEFFICIENTS FOR EQUIVALENT IR EXTINCTION 8.0 - 12.0 MICRONS

HRS (MST)	YPENBURG JANUARY							
1 - 8	1087168491	1086970346	969399791	1205201394	1205067504	1053219311	818145011	1205198831
9 - 16	1239082999	1491266292	1507781362	1255661302	1373170418	1424090099	1306454771	1037557999
17 - 24	1121117166	1003282668	1020848366	1054007533	1238295277	986570984	1070852339	936109044
HRS (MST)	YPENBURG FEBRUARY							
1 - 8	1322905328	1440408052	1239212523	1289286130	1137828332	1070324718	1305861612	801626091
9 - 16	1120984041	1172301034	1423236338	1440476408	1356590582	1289547250	1272506873	1222308344
17 - 24	1239478519	1138094840	1238756082	1272704247	1154411252	1104211191	1171712755	1171579888
HRS (MST)	YPENBURG MARCH							
1 - 8	986113525	1070327284	918937588	885383156	733535220	632741107	851566324	1070127354
9 - 16	1187633650	1642196215	1524427258	1743253752	1760096762	1625682170	1743386106	1625551610
17 - 24	1675818490	1507980794	1390341626	1390342394	1272641017	1222112506	1205334009	1305929461
HRS (MST)	YPENBURG APRIL							
1 - 8	937161207	870248435	919859188	701163508	1070067701	1474229237	1507911408	1726737392
9 - 16	1541467386	1760752890	1592258041	1827795705	1945237498	1894904826	1911748089	1777464570
17 - 24	1526003194	1609757944	1071970298	1138947321	1205990650	1038086649	1004861177	1222768889
HRS (MST)	YPENBURG MAY							
1 - 8	584643318	432598518	382855409	952887531	1004201195	1592193008	1625615597	1642851574
9 - 16	1777661178	1978856954	1895036665	1978922490	1945170935	1962014458	2113600250	2079914234
17 - 24	1844704506	1911813368	1475148538	735639290	903213817	568981498	365491701	651098352
HRS (MST)	YPENBURG JUNE							
1 - 8	1121056250	517535482	970255352	801895926	1189277173	1811281655	1676275706	1844902650
9 - 16	1827666170	1844837114	1760885498	1792849082	2063071226	2012936954	1945303290	2012740346
17 - 24	2046228218	1811479290	1676408055	1542585082	1559296762	1106049530	854260218	1021244919
HRS (MST)	YPENBURG JULY							
1 - 8	685241594	600306425	582936314	533666569	1003613687	1424093943	1810429690	1844704761
9 - 16	1911945464	1844638714	1878193914	1777071097	1895167482	1995831290	1911748346	1945237242
17 - 24	1911879418	1895299066	1575876602	1542519289	1240333050	736164602	618329850	701560826
HRS (MST)	YPENBURG AUGUST							
1 - 8	348516858	347271925	297266936	448324592	163310328	920054770	1675750130	1676079091
9 - 16	1962276858	1945631482	2012609274	1928525816	2063071994	2012543738	2029648634	2046229242
17 - 24	2029385722	1609562361	1189279226	685897722	819788538	517995258	450558200	516814327
HRS (MST)	YPENBURG SEPTEMBER							
1 - 8	768078329	785248506	482275832	700771832	718335477	818739194	1457909233	1861415923
9 - 16	2012543226	1945367800	2063071226	2046294778	1979250936	1962211578	2012739578	2063071994
17 - 24	1895168762	1559361784	1458830074	1224014586	937687802	718797562	668596730	583921658
HRS (MST)	YPENBURG OCTOBER							
1 - 8	296668664	381145318	330752242	263244003	213308394	498062058	280090341	1256169946
9 - 16	1255661803	1407312877	1525019336	1659695094	1693382135	1710487802	1777530362	1357652666
17 - 24	651487987	650572789	331478003	212919026	331736054	112581611	230220020	330553070
HRS (MST)	YPENBURG NOVEMBER							
1 - 8	1120591089	801168105	1120262119	817550568	682874340	380289748	784194025	1002954222
9 - 16	1188226536	1340008940	1507519469	1625942511	1642391024	1575021303	1356654834	1374089463
17 - 24	1155788018	1373695474	1441001720	1020454898	1071377141	1154999540	1171320052	1003612405
HRS (MST)	YPENBURG DECEMBER							
1 - 8	1104205539	1003477224	784783085	902353892	1019467236	885249767	884790761	1104144622
9 - 16	1036905204	1441263348	1289545200	1591930103	1642524922	1424026874	1474622967	1222373114
17 - 24	1222108918	968877554	1255664369	1037362161	1104142580	1036836082	767941359	1053742565

ALPHA WEIBULL COEFFICIENTS FOR 10M WIND SPEED

HRS (MST)								
	YPENBURG JANUARY							
1 - 8	0.09186661	0.11423469	0.08676714	0.06185002	0.07026362	0.06805176	0.05060009	0.04905256
9 - 16	0.06079938	0.01324533	0.02547873	0.02221762	0.03194191	0.04366263	0.06702298	0.07621258
17 - 24	0.10599011	0.08129114	0.09139943	0.07306796	0.06655198	0.08345473	0.06042233	0.08492172
HRS (MST)	YPENBURG FEBRUARY							
1 - 8	0.07361966	0.08603162	0.07914919	0.09248370	0.08215320	0.05053889	0.03599717	0.05053576
9 - 16	0.03411668	0.01620308	0.01787134	0.01775411	0.02034944	0.02524963	0.03072008	0.04852775
17 - 24	0.05044254	0.05471536	0.10913497	0.09582430	0.08069348	0.09114420	0.06954807	0.07674092
HRS (MST)	YPENBURG MARCH							
1 - 8	0.07881320	0.06494218	0.07265812	0.07552481	0.07554859	0.05301545	0.03986587	0.03064325
9 - 16	0.01275958	0.01042457	0.01286019	0.00599732	0.00560525	0.01507726	0.01726256	0.02266836
17 - 24	0.03123214	0.04171310	0.04450703	0.03976555	0.05063635	0.03993372	0.06396544	0.07488096
HRS (MST)	YPENBURG APRIL							
1 - 8	0.12103111	0.16228205	0.15018386	0.10956180	0.07078600	0.04192432	0.01998455	0.01596539
9 - 16	0.01520048	0.01322028	0.01112840	0.00657111	0.01062993	0.00905760	0.02001334	0.02577245
17 - 24	0.04530450	0.06452644	0.07846040	0.06247132	0.07156307	0.08013350	0.08934671	0.11280090
HRS (MST)	YPENBURG MAY							
1 - 8	0.09260219	0.10602587	0.09699380	0.06646794	0.03962284	0.02696745	0.01907606	0.01395014
9 - 16	0.01137467	0.00911698	0.01851232	0.00561718	0.00670638	0.00591787	0.01300536	0.02855970
17 - 24	0.03768357	0.04304556	0.06999195	0.08282810	0.09290326	0.08503735	0.08125007	0.09300506
HRS (MST)	YPENBURG JUNE							
1 - 8	0.15126866	0.15885848	0.11081743	0.14229840	0.07297450	0.05940671	0.04573653	0.03987800
9 - 16	0.02086402	0.00915867	0.00618813	0.02300095	0.00717133	0.01988256	0.02587372	0.01856568
17 - 24	0.05605141	0.06078292	0.06373841	0.10994917	0.09851319	0.13198924	0.10529411	0.14389557
HRS (MST)	YPENBURG JULY							
1 - 8	0.10685790	0.11729598	0.11869311	0.07049114	0.05694610	0.04859805	0.03087325	0.02136756
9 - 16	0.02077317	0.01224655	0.00734406	0.00449016	9.00535510	0.01423183	0.02323471	0.02431818
17 - 24	0.03278939	0.05354511	0.08285111	0.10125005	0.10712308	0.09455091	0.11119378	0.09479171
HRS (MST)	YPENBURG AUGUST							
1 - 8	0.26163209	0.24756008	0.22765410	0.20363641	0.15319228	0.09135342	0.08469731	0.04421419
9 - 16	0.05731161	3.04285762	0.02271697	0.01992848	0.02181501	0.02834105	0.04187648	0.08093947
17 - 24	0.16332304	0.17331535	0.22726858	0.26509672	0.29841805	0.21796513	0.21899605	0.20519966
HRS (MST)	YPENBURG SEPTEMBER							
1 - 8	0.14541095	0.15754014	0.14800090	0.15357906	0.10080433	0.07187170	0.05220487	0.03965179
9 - 16	0.02763098	0.02079057	0.01458278	0.01250884	0.01700250	0.02271638	0.04201525	0.08904999
17 - 24	0.12808329	0.18793708	0.21208584	0.20666218	0.17416596	0.17130119	0.16717559	0.18406123
HRS (MST)	YPENBURG OCTOBER							
1 - 8	0.22419089	0.21288651	0.25082105	0.16427451	0.21650392	0.13042712	0.14765537	0.07541221
9 - 16	0.05305859	0.05349305	0.04263931	0.02982222	0.05602533	0.05501941	0.08944494	0.11983752
17 - 24	0.18838406	0.19117999	0.20496321	0.17271507	0.18223530	0.23247623	0.25178617	0.24061853
HRS (MST)	YPENBURG NOVEMBER							
1 - 8	0.05075664	0.04921205	0.04410524	0.05833379	0.05609719	0.06784999	0.04827876	0.02759448
9 - 16	0.02103287	0.01198265	0.01218990	0.00867692	0.00968591	0.01601385	0.03010178	0.04210651
17 - 24	0.03867324	0.04510593	0.06868374	0.06201492	0.10154945	0.06220191	0.06650168	0.06391835
HRS (MST)	YPENBURG DECEMBER							
1 - 8	0.02916274	0.04288412	0.03313919	0.03957329	0.03818414	0.03381521	0.03005617	0.01829780
9 - 16	0.00861921	0.00613773	0.00939571	0.00599568	0.00837015	0.01026880	0.02600423	0.03750148
17 - 24	0.02307704	0.02415795	0.02325420	0.02936554	0.02876046	0.02269237	0.02643705	0.03786412

BETA WEIBULL COEFFICIENTS FOR 10M WIND SPEED

HRS (MST)								
	YPENBURG JANUARY							
1 - 8	1.46476364	1.40742970	1.58518314	1.80592823	1.57663822	1.59430213	1.78404331	1.78852558
9 - 16	1.61024094	2.41250515	2.04533482	2.18322468	2.02737141	1.74831390	1.69215202	1.58708572
17 - 24	1.34896374	1.52191830	1.47659683	1.60427380	1.67049980	1.55296707	1.81521606	1.61949825
HRS (MST)	YPENBURG FEBRUARY							
1 - 8	1.70897865	1.66987705	1.66360569	1.55983162	1.60851765	1.89963245	2.07461548	1.80832386
9 - 16	1.97643185	2.39020538	2.37783146	2.36086273	2.28319168	2.21475697	2.18372822	1.89614105
17 - 24	1.96576405	1.88451004	1.42827129	1.50417519	1.67703724	1.55917931	1.76086426	1.72150135
HRS (MST)	YPENBURG MARCH							
1 - 8	1.44480324	1.53238392	1.48550415	1.49575710	1.46309757	1.69078732	1.76769829	1.88994598
9 - 16	2.30664444	2.32747364	2.16877174	2.55966854	2.61209011	2.15443611	2.10322762	2.08967876
17 - 24	2.00364208	1.84940434	1.80480385	1.81700325	1.65592670	1.73639774	1.56723499	1.49500656
HRS (MST)	YPENBURG APRIL							
1 - 8	1.53029537	1.29876900	1.30791092	1.44486332	1.67915630	1.93085861	2.22563934	2.29829693
9 - 16	2.28840351	2.30193329	2.35938931	2.66752625	2.42522539	2.55976295	2.22537136	2.14191914
17 - 24	1.94188595	1.78937340	1.69822311	1.87150574	1.85228634	1.77701759	1.78092766	1.63285351
HRS (MST)	YPENBURG MAY							
1 - 8	1.87579918	1.81564331	1.76422310	1.91973209	2.11055279	2.23798656	2.34498024	2.47357178
9 - 16	2.54196644	2.63955307	2.24849129	2.82396698	2.72923183	2.89942265	2.49955845	2.14351177
17 - 24	2.10556126	2.07218170	1.89532089	1.79394531	1.73108959	1.82387638	1.89273834	1.84062290
HRS (MST)	YPENBURG JUNE							
1 - 8	1.51696110	1.39986324	1.63671494	1.49689293	1.80945969	1.94728756	2.00161743	2.08091068
9 - 16	2.46182919	2.79860497	3.02669048	2.18754673	2.91325951	2.28306007	2.17718220	2.41765495
17 - 24	1.86607075	1.76204777	1.89838409	1.57501316	1.74106503	1.60852623	1.85687542	1.53273106
HRS (MST)	YPENBURG JULY							
1 - 8	1.71637249	1.68141460	1.65568924	1.87420845	1.92856789	1.96388531	2.14725971	2.33341599
9 - 16	2.25669956	2.47926903	2.76307583	2.97480488	2.90266323	2.47494888	2.20131493	2.22536414
17 - 24	2.14182091	1.91930771	1.69329834	1.61307621	1.58770466	1.71246052	1.65698858	1.77260971
HRS (MST)	YPENBURG AUGUST							
1 - 8	1.19271660	1.27293682	1.27534580	1.20946121	1.40303802	1.64842319	1.69442177	1.95923233
9 - 16	1.71828556	1.91952801	2.21480846	2.32413483	2.27736378	2.19681454	1.98505211	1.74326229
17 - 24	1.39436817	1.47940170	1.33367825	1.27579498	1.23125362	1.36996315	1.33275700	1.39055933
HRS (MST)	YPENBURG SEPTEMBER							
1 - 8	1.51649857	1.38933849	1.43650532	1.35922813	1.56445408	1.72230625	1.80300522	1.99434566
9 - 16	2.07228088	2.20176220	2.44413471	2.53142929	2.36299992	2.30289745	2.07020473	1.68345165
17 - 24	1.50405979	1.40400124	1.32419777	1.25282001	1.37575340	1.37861538	1.40196514	1.31193924
HRS (MST)	YPENBURG OCTOBER							
1 - 8	1.25224972	1.35301018	1.14216709	1.46219826	1.29368496	1.57061577	1.38477898	1.64693069
9 - 16	1.80232811	1.75736237	1.85894871	2.06069374	1.71403694	1.82549191	1.63193798	1.55782509
17 - 24	1.33862972	1.32465553	1.35406971	1.38537884	1.29706287	1.14905548	1.14251232	1.20087624
HRS (MST)	YPENBURG NOVEMBER							
1 - 8	1.59641647	1.64759827	1.74752617	1.57975483	1.64779091	1.55734253	1.68839455	1.92791367
9 - 16	1.96965790	2.23122406	2.23596954	2.40831375	2.39863491	2.20688959	1.91779137	1.74104977
17 - 24	1.83165550	1.67695608	1.47875977	1.50831127	1.22713947	1.44649506	1.43111324	1.48416042
HRS (MST)	YPENBURG DECEMBER							
1 - 8	1.93122292	1.71067524	1.75007915	1.75040627	1.74428654	1.77630329	1.91265774	2.09255028
9 - 16	2.44695950	2.56322861	2.33581829	2.62556744	2.51809120	2.44522285	1.98585320	1.78707600
17 - 24	2.06354237	2.00271130	2.01172161	1.88260078	1.88829327	1.99567604	1.93266678	1.77282810

ALPHA WEIBULL COEFFICIENTS FOR 2M WIND SPEED

HRS (MST)	YPENBURG JANUARY							
1 - 8	0.65475518	0.80419374	0.65027022	0.76159006	0.72560024	0.70394450	0.58321881	0.61487681
9 - 16	0.48770696	0.47029907	0.44117618	0.38974679	0.29031861	0.43332356	0.50340927	0.53924543
17 - 24	0.50544810	0.63574910	0.72141230	0.64638978	0.59228915	0.69159329	0.67441726	0.76754642

HRS (MST)	YPENBURG FEBRUARY							
1 - 8	0.78313476	0.83853900	0.70172864	0.79866213	0.75385189	0.87529385	0.70544124	0.59211516
9 - 16	0.42736512	0.40850097	0.31432712	0.36821103	0.32052147	0.35674536	0.31320894	0.42370808
17 - 24	0.58126622	0.69361585	0.66689032	0.91254151	0.77275366	0.76792884	0.95778620	0.81018066

HRS (MST)	YPENBURG MARCH							
1 - 8	0.64230406	0.65279001	0.68292481	0.65061665	0.80309892	0.55661827	0.54735041	0.51020658
9 - 16	0.40468615	0.32032442	0.24025100	0.24014080	0.18498915	0.20273322	0.22048098	0.25643924
17 - 24	0.37619441	0.57666224	0.52195621	0.43757200	0.48313320	0.44799346	0.61379844	0.58065474

HRS (MST)	YPENBURG APRIL							
1 - 8	0.85287696	0.81630039	0.72569531	0.81027895	0.85771090	0.78787434	0.72064251	0.47597343
9 - 16	0.33042359	0.28153431	0.28787750	0.21825612	0.16091353	0.12394369	0.16976321	0.16239089
17 - 24	0.28184462	0.33902991	0.59857142	0.62387979	0.96750486	0.84888047	0.82624972	0.86425942

HRS (MST)	YPENBURG MAY							
1 - 8	2.85262775	0.97100496	2.75719166	2.24186325	2.02864742	1.75773430	1.37892151	1.37750912
9 - 16	1.18674088	0.80432206	0.51003671	0.61044621	0.41280681	0.53475225	0.44450343	0.61303753
17 - 24	0.64207959	0.98890632	1.15331063	1.15867615	1.66445351	1.74926567	2.57451820	2.01920891

HRS (MST)	YPENBURG JUNE							
1 - 8	1.85280895	1.30797100	1.74903393	2.02383900	1.49898338	1.43975258	1.09861946	1.00767899
9 - 16	0.96731865	0.69962740	0.73025477	0.42836398	0.36868954	0.28686869	0.31408471	0.37268424
17 - 24	0.72207568	0.81931299	1.03121376	1.13692284	99.00000000	99.00000000	99.00000000	1.22757816

HRS (MST)	YPENBURG JULY							
1 - 8	0.98722184	1.50557899	1.38257885	1.66437054	1.44046307	1.02682972	1.26273918	1.02718258
9 - 16	0.76274526	0.75563914	0.57183766	0.69565624	0.46047693	0.34958142	0.54876661	0.50894803
17 - 24	0.44571418	0.58627307	0.95152295	1.22691441	1.65496159	1.80706406	1.12008286	1.27005005

HRS (MST)	YPENBURG AUGUST							
1 - 8	1.04243774	1.46176919	2.04407787	1.25344944	1.27483368	1.88841915	1.23729134	1.10311604
9 - 16	0.98583937	0.76659644	0.60622770	0.82327396	0.78636330	0.67468750	0.66386259	0.66788936
17 - 24	0.86182058	1.29715729	1.23647404	1.36662483	1.91515923	1.75714111	2.06631565	1.78682137

HRS (MST)	YPENBURG SEPTEMBER							
1 - 8	1.90776539	1.42248821	1.16882133	1.48272705	1.45996189	1.35908699	1.03069401	0.99838674
9 - 16	0.61094528	0.63479584	0.59613431	0.60239208	0.79886252	0.46586737	0.45313627	0.65521586
17 - 24	0.86678028	1.81580734	2.24546242	1.40230179	1.59509468	1.06532574	1.41287899	1.56574535

HRS (MST)	YPENBURG OCTOBER							
1 - 8	1.58302784	1.37964153	1.67866039	1.52860928	1.98631573	1.84412193	1.87167358	0.92092413
9 - 16	0.87044930	0.73280978	0.90413076	0.82869542	0.53558481	0.75757080	1.12947273	1.13315010
17 - 24	1.45542240	1.75950623	1.59943676	1.28511741	1.21533298	1.25961971	1.60234928	1.54895306

HRS (MST)	YPENBURG NOVEMBER							
1 - 8	0.60882711	0.60226351	0.51948613	0.54327917	0.49779499	0.59659028	0.54104090	0.55641830
9 - 16	0.42292953	0.32766902	0.31117278	0.28866380	0.26486069	0.25406289	0.39115345	0.60564828
17 - 24	0.47675234	0.48650533	0.53092790	0.61522663	0.58869410	0.65862381	0.59700096	0.50304550

HRS (MST)	YPENBURG DECEMBER							
1 - 8	0.43898827	0.54105896	0.43096024	0.37082171	0.49901819	0.40478063	0.50147152	0.44395965
9 - 16	0.35730678	0.26567149	0.24754143	0.18323511	0.25371057	0.32822073	0.33188862	0.40614879
17 - 24	0.48711830	0.42392653	0.39993024	0.40094179	0.41989899	0.41916645	0.51954055	0.52958351

BETA WEIBULL COEFFICIENTS FOR 2M WIND SPEED

HRS (MST)	YPENBURG JANUARY							
1 - 8	1.14261150	0.88951975	1.06745243	0.87021083	0.87097239	0.94453639	1.02657986	1.90568771
9 - 16	1.20284367	1.18488121	1.18514061	1.50844193	1.72162533	1.29135036	1.29934883	1.11175919
17 - 24	1.21150303	0.93191469	1.02921867	1.11061382	1.10891438	1.03733253	0.97243333	1.05516148
HRS (MST)	YPENBURG FEBRUARY							
1 - 8	1.03859901	1.10533905	1.19178009	1.07409954	1.10103989	0.98188996	1.32293797	1.40517521
9 - 16	1.43755722	1.42763138	1.83690166	1.65602970	1.85580730	1.62701988	1.84443760	1.63517952
17 - 24	1.46586227	1.26729298	1.22031403	0.93831408	1.29000664	1.17018890	1.02892876	1.07905293
HRS (MST)	YPENBURG MARCH							
1 - 8	1.01111889	0.94826585	0.94743955	1.08454514	0.90565783	1.26800728	1.23501778	1.24759579
9 - 16	1.24657345	1.42291260	1.51423073	1.55769444	1.67436790	1.69262218	1.58074951	1.59584236
17 - 24	1.32045555	1.04624939	1.16998482	1.34610344	1.28112602	1.24067688	0.96634251	1.09147644
HRS (MST)	YPENBURG APRIL							
1 - 8	1.00803757	0.98443890	1.03049088	0.92085347	0.91476035	0.81843579	0.90351146	1.18450642
9 - 16	1.42340374	1.45422173	1.37656212	1.52876854	1.74795437	1.92935181	1.60387897	1.73486233
17 - 24	1.50244045	1.49648762	1.08522415	1.18624496	0.77487600	1.02894402	1.08430767	1.03590298
HRS (MST)	YPENBURG MAY							
1 - 8	0.00000000	3.00000006	0.40080661	0.44956249	0.73793739	0.84080088	0.77804166	0.78531623
9 - 16	0.78844661	1.18155520	1.63750362	1.40214348	1.75010967	1.36188984	1.47654533	1.36928940
17 - 24	1.35838223	1.02686882	0.99742270	1.18673420	0.94084066	0.84325433	0.00000000	0.62604326
HRS (MST)	YPENBURG JUNE							
1 - 8	0.68575644	0.78325105	0.74633420	0.79010683	0.88546169	0.68931532	0.91806215	0.84630847
9 - 16	0.81566894	1.09329987	1.53317356	1.78816319	1.72333527	2.08458519	2.06278133	1.81175232
17 - 24	1.23191357	1.14115906	1.11951065	1.12185287	99.00000000	99.00000000	99.00000000	1.06944752
HRS (MST)	YPENBURG JULY							
1 - 8	1.36486435	0.93413550	0.80827785	0.72358400	0.83991683	1.08990669	0.96793032	0.94581085
9 - 16	1.30464840	1.14254379	1.46401119	1.09451675	1.51306820	1.78336620	1.25087452	1.38735580
17 - 24	1.56183434	1.40281773	0.99881148	0.90651584	0.85344839	0.54732496	1.17255592	0.99485612
HRS (MST)	YPENBURG AUGUST							
1 - 8	0.63039178	0.80326790	0.48163950	0.91715902	0.98964465	0.65600324	0.86961526	1.07868481
9 - 16	0.92093605	1.06708908	1.25718594	0.89575368	1.14382648	1.68578396	1.14638615	1.28676605
17 - 24	0.99812746	0.75717360	1.04236031	1.13634205	0.66958553	0.86495382	0.58794242	0.73578602
HRS (MST)	YPENBURG SEPTEMBER							
1 - 8	0.62160045	0.69398248	1.27211189	0.67045289	0.72356927	0.75283504	1.09287167	1.11155510
9 - 16	1.35852909	1.24553585	1.44647884	1.24227524	1.02640915	1.43670273	1.54622269	1.31828213
17 - 24	1.30280113	0.67399937	0.55259871	0.99373364	0.91864884	1.36634636	0.98954421	0.74988258
HRS (MST)	YPENBURG OCTOBER							
1 - 8	0.84512514	1.29813576	0.86435270	0.90612280	0.55023497	0.78105628	0.57885444	1.26263332
9 - 16	1.27253246	1.63263321	1.01892757	1.16713238	1.79692173	1.56489849	0.86865056	0.82378918
17 - 24	0.95283806	0.75182432	0.77845126	0.80325866	1.44906521	1.00429630	0.83862686	0.76581913
HRS (MST)	YPENBURG NOVEMBER							
1 - 8	0.97965586	1.04920387	1.33863544	1.23740196	1.27966690	1.24018288	1.18870831	1.28692150
9 - 16	1.48324299	1.53157997	1.52501297	1.52300358	1.67191029	1.72806168	1.28198814	1.15890026
17 - 24	1.26408958	1.23386002	1.18159771	1.[illegible]8182	1.05370808	0.95248199	1.12540913	1.19980812
HRS (MST)	YPENBURG DECEMBER							
1 - 8	1.39426899	1.35481644	1.35181713	1.49436406	1.16639137	1.23777866	1.20180511	1.32821369
9 - 16	1.50872231	1.70717907	1.74550629	1.98795128	1.73518276	1.46243000	1.46950626	1.29840183
17 - 24	1.21106625	1.32684135	1.31100655	1.40027905	1.32533360	1.27152348	1.18092728	1.12665176

ALPHA WEIBULL COEFFICIENTS FOR HUMIDITY

HRS (MST)	YPENBURG JANUARY							
1 - 8	0.11281908	0.11675245	0.14509350	0.13165683	0.15780377	0.16296971	0.12331825	0.11289865
9 - 16	0.07096016	0.05080797	0.02349587	0.02472200	0.01609477	0.02212033	0.01752965	0.01619272
17 - 24	0.02947840	0.05457417	0.07523835	0.10116297	0.09362066	0.11808479	0.11390281	0.11727136

HRS (MST)	YPENBURG FEBRUARY							
1 - 8	0.09206545	0.07577378	0.06888235	0.07054919	0.08331066	0.08667356	0.08578300	0.07188982
9 - 16	0.03898571	0.02833967	0.02201453	0.01408194	0.01533669	0.01350747	0.00933820	0.01091209
17 - 24	0.01251855	0.01850459	0.02442247	0.03823475	0.06608963	0.08286643	0.08970183	0.08450431

HRS (MST)	YPENBURG MARCH							
1 - 8	0.14005232	0.13246351	0.11888933	0.14628989	0.18865126	0.18400663	0.14135486	0.05427397
9 - 16	0.01961355	0.00855516	0.00813431	0.00113580	0.00044708	0.00052015	0.00118656	0.00068754
17 - 24	0.00071388	0.00113303	0.00611518	0.02392051	0.04551544	0.08420211	0.12647897	0.13871098

HRS (MST)	YPENBURG APRIL							
1 - 8	0.06125053	0.07273532	0.09352249	0.13322604	0.12569457	0.09057742	0.03577270	0.00769258
9 - 16	0.00497724	0.00182076	0.00099692	0.00040672	0.00011754	0.00020108	0.00043731	0.00031077
17 - 24	0.00201920	0.00102417	0.00311254	0.00941119	0.01197381	0.02455676	0.02599865	0.03978505

HRS (MST)	YPENBURG MAY							
1 - 8	0.09862441	0.10912943	0.14071596	0.15266985	0.14553267	0.02903024	0.00930559	0.00545486
9 - 16	0.00190395	0.00103667	0.00041426	0.00022612	0.00017506	0.00033560	0.00052193	0.00049142
17 - 24	0.00014420	0.00039632	0.00139706	0.00691292	0.02952567	0.03883645	0.06369126	0.06891072

HRS (MST)	YPENBURG JUNE							
1 - 8	0.13556886	0.13095224	0.10812718	0.14988869	0.13199669	0.03952222	0.00514615	0.00060087
9 - 16	0.00045685	0.00007402	0.00016882	0.00209215	0.00103331	0.00449638	0.00009048	0.00020116
17 - 24	0.00056395	0.00619181	0.00114283	0.00422352	0.01690608	0.03616188	0.05482342	0.09718663

HRS (MST)	YPENBURG JULY							
1 - 8	0.06455332	0.05749095	0.07333958	0.10538757	0.08451051	0.03533591	0.00267456	0.00069133
9 - 16	0.00051685	0.00108007	0.00015064	0.00037077	0.00013138	0.00016423	0.00007271	0.00016215
17 - 24	0.00005508	0.00009926	0.00033117	0.00121229	0.01672524	0.04306756	0.05136851	0.06065691

HRS (MST)	YPENBURG AUGUST							
1 - 8	0.19430715	0.18194407	0.22126311	0.23337543	0.23994255	0.19840896	0.08835906	0.01182394
9 - 16	0.00177002	0.00030781	0.00013254	0.00046842	0.00016464	0.00002500	0.00008948	0.00050090
17 - 24	0.00101532	0.00256695	0.01676837	0.07165796	0.10460621	0.13076252	0.15894860	0.18780059

HRS (MST)	YPENBURG SEPTEMBER							
1 - 8	0.24330074	0.22511792	0.19785494	0.16285193	0.18232709	0.23454911	0.13894016	0.02211440
9 - 16	0.00605616	0.00165257	0.00048379	0.00039375	0.00011716	0.00003479	0.00010463	0.00077936
17 - 24	0.00138858	0.00767288	0.03608392	0.10693556	0.11302018	0.16801071	0.19596487	0.19659215

HRS (MST)	YPENBURG OCTOBER							
1 - 8	0.22574741	0.21913522	0.24000227	0.24252933	0.32468313	0.28675354	0.21792376	0.15156919
9 - 16	0.03454670	0.01909428	0.01173428	0.00806890	0.00431672	0.00384343	0.00365634	0.00797715
17 - 24	0.02571488	0.09896713	0.15254617	0.15521622	0.17393726	0.17984617	0.19156247	0.22697902

HRS (MST)	YPENBURG NOVEMBER							
1 - 8	0.10592818	0.11256075	0.15165812	0.15844524	0.15221161	0.18155533	0.14435989	0.14777511
9 - 16	0.08237195	0.01753599	0.01556349	0.01276902	0.00646036	0.00434776	0.00584792	0.01274480
17 - 24	0.02567379	0.04172166	0.07610106	0.09834677	0.08764637	0.08003503	0.10297781	0.10314476

HRS (MST)	YPENBURG DECEMBER							
1 - 8	0.14320028	0.13655460	0.11743575	0.11504722	0.10398823	0.11298418	0.16138411	0.16848081
9 - 16	0.15841460	0.06388998	0.04011858	0.02782333	0.01692311	0.01304502	0.02182776	0.02886807
17 - 24	0.05540389	0.07346338	0.05872804	0.07293081	0.09169108	0.10841429	0.10109603	0.13037878

BETA WEIBULL COEFFICIENTS FOR HUMIDITY

HRS (MST)								
	YPENBURG JANUARY							
1 - 8	0.94453686	0.93551522	0.85825503	0.89578968	0.81887740	0.80709958	0.89233381	0.91238755
9 - 16	1.10084915	1.14839458	1.31881618	1.25596333	1.36767578	1.27169991	1.37392330	1.47604752
17 - 24	1.33066940	1.14393520	1.07914352	0.92941093	0.94629091	0.89075279	0.93386066	0.91608196
HRS (MST)	YPENBURG FEBRUARY							
1 - 8	1.02976799	1.10593700	1.15436554	1.17254734	1.10839939	1.09676647	1.11945343	1.13433170
9 - 16	1.28322601	1.26124191	1.28350925	1.36585999	1.31086540	1.30610752	1.45071226	1.44987011
17 - 24	1.49973011	1.43913841	1.35765648	1.20522785	1.05772018	0.99383646	0.98836970	1.04535484
HRS (MST)	YPENBURG MARCH							
1 - 8	0.84454393	0.86281049	0.89464754	0.84100401	0.78725743	0.81180423	0.87207764	1.11227894
9 - 16	1.26757240	1.43655205	1.32611370	1.91309452	2.12660408	2.05609035	1.83732605	2.03878403
17 - 24	2.10595608	2.12217236	1.72742176	1.35094357	1.16012859	0.95618165	0.82958323	0.81838757
HRS (MST)	YPENBURG APRIL							
1 - 8	1.10259151	1.09058666	0.97956729	0.88112080	0.91809118	0.98361969	1.14119244	1.42979622
9 - 16	1.43495274	1.66962051	1.81685162	2.04053879	2.41123295	2.22043991	1.97625732	2.13609886
17 - 24	1.64937019	1.94070148	1.71028423	1.48600388	1.48276138	1.31672668	1.35329533	1.24252796
HRS (MST)	YPENBURG MAY							
1 - 8	0.90969467	0.93713319	0.89542139	0.88033235	0.88367367	1.29851151	1.43034744	1.44627190
9 - 16	1.60806179	1.68161869	1.94139957	2.10252380	2.10626507	1.92441940	1.79113388	1.83077240
17 - 24	2.28245926	2.07160568	1.75446606	1.48066235	1.09550667	1.09935665	0.97838086	1.01597309
HRS (MST)	YPENBURG JUNE							
1 - 8	0.92966169	0.93640459	1.00507069	0.90017217	0.95064276	1.22871876	1.76054382	2.20671749
9 - 16	2.13747787	2.60523701	2.26728535	1.47874737	1.67436123	1.22126579	2.37159157	2.19672394
17 - 24	1.93137836	2.35677814	1.99091053	1.74288845	1.42159939	1.25256062	1.17634201	0.99516463
HRS (MST)	YPENBURG JULY							
1 - 8	1.18842983	1.28774548	1.22327137	1.09423828	1.12675095	1.30703354	1.99587631	2.26025295
9 - 16	2.21885014	1.90695000	2.42987061	2.10130882	2.36062527	2.28285599	2.52934456	2.30734825
17 - 24	2.71149445	2.62572575	2.46213436	2.23884869	1.45956230	1.19954967	1.18822289	1.17323494
HRS (MST)	YPENBURG AUGUST							
1 - 8	0.96955776	1.00517082	0.90058452	0.87168127	0.84385324	0.86016923	1.01398277	1.52757549
9 - 16	1.94403744	2.37191963	2.56865501	2.15853691	2.44523048	2.96420574	2.62009907	2.16254139
17 - 24	2.07245255	1.91587639	1.46342087	1.13503170	1.06336594	1.06867693	1.01465607	0.93434125
HRS (MST)	YPENBURG SEPTEMBER							
1 - 8	0.70302778	0.71312010	0.76651436	0.84164256	0.85011989	0.75676417	0.86845303	1.33638763
9 - 16	1.59610748	1.89245796	2.14591312	2.14911938	2.51395321	2.86461830	2.48589802	1.94376087
17 - 24	1.92016029	1.61013889	1.27809620	0.94280607	0.98669684	0.82808638	0.76556927	0.78933895
HRS (MST)	YPENBURG OCTOBER							
1 - 8	0.72735655	0.75759208	0.75016367	0.74988872	0.62488192	0.67031538	0.74178100	0.80296969
9 - 16	1.14101791	1.24978065	1.31066227	1.35533237	1.53594017	1.55284119	1.58698559	1.46905613
17 - 24	1.29273605	0.92183620	0.80153340	0.86143303	0.80815083	0.78651071	0.75650716	0.75327772
HRS (MST)	YPENBURG NOVEMBER							
1 - 8	0.88860738	0.89502311	0.75093934	0.75482780	0.75631279	0.73512918	0.78254062	0.75966835
9 - 16	0.89267451	1.32724667	1.31321812	1.34489155	1.56486416	1.64323997	1.57294655	1.38853931
17 - 24	1.22916412	1.11[illegible]7240	0.93997371	0.8[illegible]87659	0.95182419	0.94179046	0.90436429	0.92499924
HRS (MST)	YPENBURG DECEMBER							
1 - 8	0.87090451	0.89193511	0.94458210	0.95271361	0.96615130	0.92446256	0.81253886	0.80046320
9 - 16	0.82288069	1.07943535	1.18536091	1.26194763	1.38688755	1.49424458	1.35768414	1.34722805
17 - 24	1.15626812	1.08305645	1.16510201	1.08195114	0.99279022	0.92369872	0.98859644	0.90112275

GAMMA JOHNSON DOUBLE-BOUNDED COEFFICIENTS FOR SKY COVER

HRS (MST)								
	YPENBURG JANUARY							
1 - 8	999.00000000	999.00000000	999.00000000	999.00000000	999.00000000	999.00000000	-0.72289968	-0.81419384
9 - 16	-1.06713390	-0.99058994	-0.92704356	999.00000000	-0.96814471	-0.87029022	-0.97280383	-0.87942553
17 - 24	999.00000000	999.00000000	999.00000000	999.00000000	999.00000000	999.00000000	999.00000000	999.00000000
HRS (MST)	YPENBURG FEBRUARY							
1 - 8	999.00000000	999.00000000	999.00000000	999.00000000	999.00000000	-0.47726023	-0.62803483	-0.65086532
9 - 16	-0.63045096	-0.51152104	-0.64587675	-0.74358236	-0.77175874	-0.59435475	-0.54879224	-0.51672649
17 - 24	999.00000000	999.00000000	999.00000000	999.00000000	999.00000000	999.00000000	999.00000000	999.00000000
HRS (MST)	YPENBURG MARCH							
1 - 8	999.00000000	999.00000000	999.00000000	999.00000000	999.00000000	-0.15363336	-0.30473554	999.00000000
9 - 16	999.00000000	-0.57903236	-0.78250710	-0.89543893	999.00000000	999.00000000	999.00000000	999.00000000
17 - 24	999.00000000	999.00000000	999.00000000	999.00000000	999.00000000	999.00000000	999.00000000	999.00000000
HRS (MST)	YPENBURG APRIL							
1 - 8	999.00000000	999.00000000	999.00000000	999.00000000	-0.56294793	-0.48769683	999.00000000	-0.46150422
9 - 16	-0.58837394	-0.53037418	-0.48576616	-0.48852259	-0.56520778	-0.41924882	999.00000000	999.00000000
17 - 24	999.00000000	999.00000000	999.00000000	999.00000000	999.00000000	999.00000000	999.00000000	999.00000000
HRS (MST)	YPENBURG MAY							
1 - 8	999.00000000	999.00000000	999.00000000	999.00000000	999.00000000	999.00000000	999.00000000	999.00000000
9 - 16	999.00000000	999.00000000	999.00000000	999.00000000	999.00000000	0.02696563	0.16657919	999.00000000
17 - 24	999.00000000	999.00000000	999.00000000	999.00000000	999.00000000	999.00000000	999.00000000	999.00000000
HRS (MST)	YPENBURG JUNE							
1 - 8	999.00000000	999.00000000	999.00000000	999.00000000	999.00000000	999.00000000	999.00000000	999.00000000
9 - 16	999.00000000	999.00000000	999.00000000	999.00000000	999.00000000	999.00000000	999.00000000	999.00000000
17 - 24	999.00000000	999.00000000	999.00000000	999.00000000	999.00000000	999.00000000	999.00000000	999.00000000
HRS (MST)	YPENBURG JULY							
1 - 8	999.00000000	999.00000000	999.00000000	999.00000000	999.00000000	-0.56427026	-0.66456586	-0.58391404
9 - 16	-0.59593236	-0.60448062	999.00000000	-0.52606684	-0.52456748	-0.32650542	-0.24333388	999.00000000
17 - 24	999.00000000	999.00000000	999.00000000	999.00000000	999.00000000	999.00000000	999.00000000	999.00000000
HRS (MST)	YPENBURG AUGUST							
1 - 8	999.00000000	999.00000000	999.00000000	999.00000000	999.00000000	-0.52756411	-0.59901309	-0.48408729
9 - 16	-0.37412840	-0.45849806	999.00000000	-0.51798987	-0.58415157	-0.45534194	-0.52905643	999.00000000
17 - 24	999.00000000	999.00000000	999.00000000	999.00000000	999.00000000	999.00000000	999.00000000	999.00000000
HRS (MST)	YPENBURG SEPTEMBER							
1 - 8	999.00000000	999.00000000	999.00000000	999.00000000	999.00000000	-0.26787257	-0.50499690	-0.28916991
9 - 16	-0.34694064	-0.52432770	999.00000000	-0.51446903	-0.54015356	-0.55821997	-0.37577510	999.00000000
17 - 24	999.00000000	999.00000000	999.00000000	999.00000000	999.00000000	999.00000000	999.00000000	999.00000000
HRS (MST)	YPENBURG OCTOBER							
1 - 8	999.00000000	999.00000000	999.00000000	999.00000000	999.00000000	-0.30813110	-0.38652247	-0.35531634
9 - 16	-0.34397113	-0.31983626	-0.28166378	-0.33706057	-0.36065966	-0.29165828	-0.26581234	-0.35380726
17 - 24	999.00000000	999.00000000	999.00000000	999.00000000	999.00000000	999.00000000	999.00000000	999.00000000
HRS (MST)	YPENBURG NOVEMBER							
1 - 8	999.00000000	999.00000000	999.00000000	999.00000000	999.00000000	999.00000000	-0.41375053	-0.53689963
9 - 16	-0.38203776	-0.53843230	-0.57288581	-0.60634685	-0.58342856	-0.55098397	-0.58516806	-0.55385703
17 - 24	999.00000000	999.00000000	999.00000000	999.00000000	999.00000000	999.00000000	999.00000000	999.00000000
HRS (MST)	YPENBURG DECEMBER							
1 - 8	999.00000000	999.00000000	999.00000000	999.00000000	999.00000000	999.00000000	-0.30707196	-0.43915921
9 - 16	-0.61014485	-0.66865998	-0.66372764	999.00000000	-0.66133257	-0.76491320	-0.72533911	-0.72228694
17 - 24	999.00000000	999.00000000	999.00000000	999.00000000	999.00000000	999.00000000	999.00000000	999.00000000

ETA JOHNSON DOUBLE-BOUNDED COEFFICIENTS FOR SKY COVER

HRS (MST)								
YPENBURG JANUARY								
1 - 8	999.00000000	999.00000000	999.00000000	999.00000000	999.00000000	999.00000000	0.37201768	0.39164809
9 - 16	0.31756322	0.41941553	0.45962662	999.00000000	0.46655160	0.47474307	0.42252469	0.40367895
17 - 24	999.00000000	999.00000000	999.00000000	999.00000000	999.00000000	999.00000000	999.00000000	999.00000000
YPENBURG FEBRUARY								
1 - 8	999.00000000	999.00000000	999.00000000	999.00000000	999.00000000	0.20329279	0.28655106	0.26134408
9 - 16	0.29929537	0.30207151	0.36591810	0.37583970	0.37047279	0.26664221	0.26422739	0.27129376
17 - 24	999.00000000	999.00000000	999.00000000	999.00000000	999.00000000	999.00000000	999.00000000	999.00000000
YPENBURG MARCH								
1 - 8	999.00000000	999.00000000	999.00000000	999.00000000	999.00000000	0.26429605	0.29536647	999.00000000
9 - 16	999.00000000	0.47663481	0.51334780	0.58714181	999.00000000	999.00000000	999.00000000	999.00000000
17 - 24	999.00000000	999.00000000	999.00000000	999.00000000	999.00000000	999.00000000	999.00000000	999.00000000
YPENBURG APRIL								
1 - 8	999.00000000	999.00000000	999.00000000	999.00000000	0.40486145	0.44486736	999.00000000	0.42212600
9 - 16	0.47382295	0.48480242	0.36066049	0.49536148	0.50691622	0.50288463	999.00000000	999.00000000
17 - 24	999.00000000	999.00000000	999.00000000	999.00000000	999.00000000	999.00000000	999.00000000	999.00000000
YPENBURG MAY								
1 - 8	999.00000000	999.00000000	999.00000000	999.00000000	999.00000000	999.00000000	999.00000000	999.00000000
9 - 16	999.00000000	999.00000000	999.00000000	999.00000000	999.00000000	0.43769026	0.43134731	999.00000000
17 - 24	999.00000000	999.00000000	999.00000000	999.00000000	999.00000000	999.00000000	999.00000000	999.00000000
YPENBURG JUNE								
1 - 8	999.00000000	999.00000000	999.00000000	999.00000000	999.00000000	999.00000000	999.00000000	999.00000000
9 - 16	999.00000000	999.00000000	999.00000000	999.00000000	999.00000000	999.00000000	999.00000000	999.00000000
17 - 24	999.00000000	999.00000000	999.00000000	999.00000000	999.00000000	999.00000000	999.00000000	999.00000000
YPENBURG JULY								
1 - 8	999.00000000	999.00000000	999.00000000	999.00000000	999.00000000	0.33321559	0.40319820	0.42546636
9 - 16	0.47622949	0.48332615	999.00000000	0.54612070	0.59725139	0.54258299	0.48383689	999.00000000
17 - 24	999.00000000	999.00000000	999.00000000	999.00000000	999.00000000	999.00000000	999.00000000	999.00000000
YPENBURG AUGUST								
1 - 8	999.00000000	999.00000000	999.00000000	999.00000000	999.00000000	0.55121985	0.51866591	0.49766064
9 - 16	0.56973124	0.51939952	999.00000000	0.80959678	0.76818961	0.82382601	0.77044314	999.00000000
17 - 24	999.00000000	999.00000000	999.00000000	999.00000000	999.00000000	999.00000000	999.00000000	999.00000000
YPENBURG SEPTEMBER								
1 - 8	999.00000000	999.00000000	999.00000000	999.00000000	999.00000000	0.58936024	0.55583632	0.53849524
9 - 16	0.53771281	0.59482408	999.00000000	0.71542048	0.79307085	0.85415345	0.69711135	999.00000000
17 - 24	999.00000000	999.00000000	999.00000000	999.00000000	999.00000000	999.00000000	999.00000000	999.00000000
YPENBURG OCTOBER								
1 - 8	999.00000000	999.00000000	999.00000000	999.00000000	999.00000000	0.45262498	0.54875189	0.50246710
9 - 16	0.52666968	0.53523928	0.50391865	0.56840969	0.54313640	0.59263593	0.50742853	0.42123801
17 - 24	999.00000000	999.00000000	999.00000000	999.00000000	999.00000000	999.00000000	999.00000000	999.00000000
YPENBURG NOVEMBER								
1 - 8	999.00000000	999.00000000	999.00000000	999.00000000	999.00000000	999.00000000	0.64049172	0.58120191
9 - 16	0.63470888	0.49088979	0.51868558	0.50212566	0.48969811	0.43380326	0.51493758	0.56399563
17 - 24	999.00000000	999.00000000	999.00000000	999.00000000	999.00000000	999.00000000	999.00000000	999.00000000
YPENBURG DECEMBER								
1 - 8	999.00000000	999.00000000	999.00000000	999.00000000	999.00000000	999.00000000	0.28271842	0.31946719
9 - 16	0.27158123	0.39297962	0.50528210	999.00000000	0.42849058	0.47773564	0.47870803	0.43824798
17 - 24	999.00000000	999.00000000	999.00000000	999.00000000	999.00000000	999.00000000	999.00000000	999.00000000

MEANS FOR TEMPERATURE (DEC C)

HRS (MST)								
	YPENBURG	JANUARY						
1 - 8	3.99	3.84	3.76	3.64	3.63	3.59	3.59	3.73
9 - 16	3.58	3.80	4.10	4.03	4.06	4.09	3.81	3.68
17 - 24	3.68	3.64	3.67	3.61	3.76	3.75	3.82	3.91
HRS (MST)	YPENBURG	FEBRUARY						
1 - 8	3.65	3.52	3.49	3.44	3.48	3.43	3.54	3.47
9 - 16	3.73	4.31	4.58	4.95	5.18	4.96	4.89	4.69
17 - 24	4.13	3.80	3.71	3.77	3.61	3.62	3.63	3.53
HRS (MST)	YPENBURG	MARCH						
1 - 8	4.73	4.58	4.70	4.52	4.44	4.53	4.62	5.71
9 - 16	7.06	7.87	8.62	8.76	9.04	8.99	8.76	8.39
17 - 24	7.75	6.72	6.03	5.75	5.43	5.36	5.10	4.68
HRS (MST)	YPENBURG	APRIL						
1 - 8	5.44	5.30	5.06	5.12	4.96	5.43	6.93	8.64
9 - 16	9.87	10.64	11.18	11.32	11.51	11.42	11.33	13.93
17 - 24	10.05	9.10	8.16	7.29	6.81	6.31	6.00	5.68
HRS (MST)	YPENBURG	MAY						
1 - 8	9.15	8.64	8.24	8.04	8.45	10.23	12.02	13.51
9 - 16	14.92	16.06	16.57	16.73	17.04	17.10	17.03	16.58
17 - 24	15.37	14.87	13.14	11.71	10.93	10.40	10.03	9.49
HRS (MST)	YPENBURG	JUNE						
1 - 8	12.01	11.69	11.61	11.50	12.19	13.38	14.65	15.80
9 - 16	16.88	17.94	18.43	18.38	18.56	18.26	18.22	17.86
17 - 24	17.40	16.35	15.10	14.17	13.30	12.95	12.63	12.38
HRS (MST)	YPENBURG	JULY						
1 - 8	13.97	13.78	13.63	13.66	13.97	14.97	16.01	17.12
9 - 16	17.81	18.45	18.93	19.23	19.53	19.54	19.28	18.81
17 - 24	18.39	17.59	16.64	15.77	15.08	14.72	14.45	14.08
HRS (MST)	YPENBURG	AUGUST						
1 - 8	14.46	14.33	14.26	14.13	14.17	14.83	16.13	17.39
9 - 16	18.49	19.40	19.78	19.96	20.11	20.11	19.75	19.28
17 - 24	18.59	17.68	16.46	15.57	15.13	14.84	14.66	14.57
HRS (MST)	YPENBURG	SEPTEMBER						
1 - 8	13.30	13.26	13.13	13.04	13.09	13.06	14.16	15.77
9 - 16	16.70	17.62	18.01	18.38	18.42	18.18	18.26	17.79
17 - 24	16.85	15.53	14.46	13.98	13.72	13.58	13.28	13.27
HRS (MST)	YPENBURG	OCTOBER						
1 - 8	9.40	9.34	9.31	9.07	9.02	9.05	9.15	10.43
9 - 16	11.92	12.86	13.65	14.07	14.40	14.50	14.27	13.44
17 - 24	12.23	11.30	10.85	10.52	10.17	9.95	9.73	9.50
HRS (MST)	YPENBURG	NOVEMBER						
1 - 8	6.65	6.41	6.43	6.38	6.23	6.33	6.39	6.44
9 - 16	7.26	7.98	8.19	8.67	8.71	8.55	8.21	7.68
17 - 24	7.34	6.96	6.74	6.67	6.63	6.68	6.53	6.49
HRS (MST)	YPENBURG	DECEMBER						
1 - 8	5.23	5.17	5.08	5.06	5.15	5.23	4.98	4.96
9 - 16	5.08	5.58	5.84	5.98	6.02	6.05	6.12	5.34
17 - 24	5.38	5.51	5.35	5.59	5.49	5.54	5.42	5.16

STANDARD DEVIATIONS FOR TEMPERATURE (DEG C)

HRS (MST)	YPENBURG JANUARY							
1 - 8	2.34	2.39	2.33	2.40	2.48	2.37	2.39	2.48
9 - 16	2.47	2.28	2.32	2.45	2.37	2.28	2.22	2.11
17 - 24	2.16	2.14	2.21	2.21	2.21	2.44	2.45	2.37

HRS (MST)	YPENBURG FEBRUARY							
1 - 8	2.59	2.46	2.42	2.37	2.40	2.38	2.41	2.47
9 - 16	2.78	2.87	3.21	3.57	3.46	3.56	3.56	3.49
17 - 24	3.26	2.94	2.82	2.73	2.60	2.60	2.65	2.61

HRS (MST)	YPENBURG MARCH							
1 - 8	2.63	2.57	2.62	2.58	2.43	2.46	2.60	2.66
9 - 16	2.93	3.19	3.22	3.12	3.13	3.07	3.07	3.07
17 - 24	2.85	2.80	2.86	2.96	2.98	2.91	2.84	2.68

HRS (MST)	YPENBURG APRIL							
1 - 8	2.91	2.86	2.72	2.78	2.72	2.70	2.58	2.97
9 - 16	3.36	3.88	3.93	3.91	3.91	4.10	4.04	4.13
17 - 24	3.88	3.53	3.12	2.89	2.98	3.00	3.03	2.93

HRS (MST)	YPENBURG MAY							
1 - 8	2.87	3.01	2.96	2.89	3.02	2.96	3.39	3.96
9 - 16	4.35	4.39	4.65	4.71	4.66	4.82	4.83	4.78
17 - 24	4.71	4.33	3.78	3.55	3.30	3.12	3.05	2.95

HRS (MST)	YPENBURG JUNE							
1 - 8	2.30	2.24	2.13	2.16	1.92	1.70	2.11	2.67
9 - 16	3.23	3.49	3.61	3.75	3.79	3.78	3.62	3.62
17 - 24	3.63	3.21	2.82	2.50	2.29	2.34	2.42	2.38

HRS (MST)	YPENBURG JULY							
1 - 8	2.39	2.24	2.15	2.25	2.06	1.79	2.05	2.56
9 - 16	2.97	3.25	3.38	3.51	3.63	3.61	3.53	3.42
17 - 24	3.10	2.97	2.66	2.49	2.47	2.52	2.46	2.44

HRS (MST)	YPENBURG AUGUST							
1 - 8	2.67	2.75	2.77	2.80	2.86	2.72	2.15	2.16
9 - 16	2.46	2.87	2.86	2.97	2.90	2.80	2.61	2.58
17 - 24	2.56	2.18	2.14	2.27	2.30	2.44	2.46	2.56

HRS (MST)	YPENBURG SEPTEMBER							
1 - 8	3.31	3.22	3.29	3.36	3.41	3.38	2.92	2.39
9 - 16	2.27	2.46	2.77	2.73	2.83	2.90	2.79	2.75
17 - 24	2.64	2.55	2.70	2.75	2.89	3.00	3.14	3.16

HRS (MST)	YPENBURG OCTOBER							
1 - 8	3.44	3.45	3.53	3.54	3.53	3.53	3.57	3.42
9 - 16	3.20	3.05	3.05	3.11	3.14	3.19	3.17	3.00
17 - 24	3.08	2.98	3.12	3.16	3.25	3.39	3.43	3.41

HRS (MST)	YPENBURG NOVEMBER							
1 - 8	3.87	3.80	3.85	3.81	3.62	3.79	3.78	3.69
9 - 16	3.80	3.81	3.82	3.90	3.93	3.88	3.83	3.85
17 - 24	3.78	3.83	3.76	3.81	3.99	3.95	4.00	3.94

HRS (MST)	YPENBURG DECEMBER							
1 - 8	3.55	3.53	3.67	3.65	3.54	3.48	3.45	3.24
9 - 16	3.32	3.43	3.63	3.55	3.61	3.50	3.40	3.44
17 - 24	3.33	3.41	3.37	3.53	3.39	3.38	3.38	3.46

MEANS FOR DEWPOINT TEMPERATURE (DEG C)

HRS (MST)	YPENBURG JANUARY							
1 - 8	2.40	2.31	2.24	2.12	2.07	2.10	1.94	1.99
9 - 16	1.93	1.84	1.69	1.39	1.29	1.36	1.26	1.42
17 - 24	1.74	1.88	2.02	1.90	1.97	2.05	2.22	2.30

HRS (MST)	YPENBURG FEBRUARY							
1 - 8	2.24	2.11	2.08	2.09	2.11	2.09	2.21	2.02
9 - 16	1.96	1.60	1.83	1.74	1.74	1.18	1.33	1.40
17 - 24	1.36	1.45	1.51	1.69	1.73	1.86	1.98	1.97

HRS (MST)	YPENBURG MARCH							
1 - 8	3.17	3.02	3.18	3.07	3.10	3.25	3.20	3.67
9 - 16	3.98	3.97	3.98	3.81	3.74	3.46	3.44	3.30
17 - 24	3.31	3.13	3.29	3.54	3.39	3.39	3.26	2.97

HRS (MST)	YPENBURG APRIL							
1 - 8	3.70	3.74	3.47	3.69	3.57	3.82	4.46	4.64
9 - 16	4.61	4.50	4.67	4.46	4.41	4.20	4.01	4.01
17 - 24	3.83	3.71	3.83	3.93	3.95	3.98	3.89	3.84

HRS (MST)	YPENBURG MAY							
1 - 8	7.20	6.95	6.79	6.66	7.04	7.87	8.32	8.48
9 - 16	8.51	8.52	8.53	8.39	8.26	8.36	8.30	8.02
17 - 24	7.86	7.75	7.17	7.42	7.41	7.51	7.53	7.35

HRS (MST)	YPENBURG JUNE							
1 - 8	10.65	10.31	10.22	10.22	10.82	11.40	11.67	11.40
9 - 16	11.17	10.97	11.03	11.12	11.03	10.73	10.50	10.66
17 - 24	10.53	10.43	10.55	10.76	10.75	10.80	10.84	10.77

HRS (MST)	YPENBURG JULY							
1 - 8	12.50	12.43	12.37	12.46	12.66	13.01	13.04	13.23
9 - 16	13.08	13.06	12.94	12.94	12.76	12.85	12.70	12.59
17 - 24	12.64	12.43	12.56	12.75	12.67	12.77	12.68	12.48

HRS (MST)	YPENBURG AUGUST							
1 - 8	13.65	13.51	13.40	13.26	13.33	13.74	14.54	14.74
9 - 16	14.53	14.46	14.45	14.41	14.34	14.08	14.07	14.10
17 - 24	14.09	14.17	14.13	14.08	13.95	13.96	13.80	13.71

HRS (MST)	YPENBURG SEPTEMBER							
1 - 8	12.09	11.96	11.94	11.85	12.07	12.06	12.68	13.23
9 - 16	13.15	13.18	12.74	12.82	12.66	12.39	12.32	12.28
17 - 24	12.31	12.48	12.37	12.18	12.20	12.12	11.91	12.07

HRS (MST)	YPENBURG OCTOBER							
1 - 8	8.25	8.27	8.20	7.90	7.78	7.97	7.85	8.77
9 - 16	9.13	9.43	9.64	9.58	9.73	9.70	9.64	9.64
17 - 24	9.70	9.33	9.14	9.13	8.81	8.52	8.31	8.33

HRS (MST)	YPENBURG NOVEMBER							
1 - 8	6.65	6.41	6.43	6.38	6.23	6.33	6.39	6.44
9 - 16	7.26	7.98	8.19	8.67	8.71	8.55	8.21	7.68
17 - 24	7.34	6.96	6.74	6.67	6.63	6.68	6.53	6.49

HRS (MST)	YPENBURG DECEMBER							
1 - 8	3.83	3.78	3.65	3.62	3.61	3.67	3.50	3.50
9 - 16	3.66	3.82	3.77	3.58	3.37	3.49	3.77	3.86
17 - 24	3.73	3.89	3.71	3.93	3.81	3.85	3.89	3.74

STANDARD DEVIATIONS FOR DEWPOINT TEMPERATURE (DEG C)

HRS (MST)	YPENBURG	JANUARY						
1 - 8	2.65	2.68	2.67	2.72	2.90	2.82	2.96	3.18
9 - 16	3.01	2.80	2.88	3.02	2.96	2.92	2.72	2.56
17 - 24	2.55	2.47	2.57	2.58	2.71	2.89	2.80	2.68

HRS (MST)	YPENBURG	FEBRUARY						
1 - 8	2.74	2.73	2.69	2.62	2.76	2.79	2.87	2.87
9 - 16	3.02	3.28	3.56	3.90	3.94	4.17	3.92	3.92
17 - 24	3.86	3.43	3 15	2.94	2.89	2.85	2.82	2.75

HRS (MST)	YPENBURG	MARCH						
1 - 8	2.91	2.78	2.89	2.76	2.67	2.67	2.85	3.21
9 - 16	3.51	3.51	3.48	3.57	3.70	3.41	3.55	3.56
17 - 24	3.32	3.58	3.31	3.22	3.25	3.31	3.28	3.05

HRS (MST)	YPENBURG	APRIL						
1 - 8	2.73	2.77	2.66	2.74	2.79	2.73	2.94	3.24
9 - 16	3.51	3.66	3.78	3.80	3.57	3.44	3.51	3.50
17 - 24	3.52	3.43	3.49	3.45	3.48	3.36	3.22	2.83

HRS (MST)	YPENBURG	MAY						
1 - 8	3.09	3.24	3.18	3.19	3.35	3.18	3.59	3.60
9 - 16	3.86	3.71	3.72	3.71	3.80	3.74	3.64	3.71
17 - 24	3.60	3.60	3.32	3.33	3.19	3.22	3.31	3.15

HRS (MST)	YPENBURG	JUNE						
1 - 8	2.42	2.49	2.41	2.36	2.31	2.38	2.43	2.49
9 - 16	2.61	2.45	2.58	2.66	2.56	2.59	2.62	2.80
17 - 24	2.69	2.61	2.64	2.56	2.39	2.43	2.55	2.49

HRS (MST)	YPENBURG	JULY						
1 - 8	2.69	2.56	2.49	2.48	2.47	2.40	2.56	2.73
9 - 16	2.68	2.77	2.77	2.81	2.85	2.83	2.78	2.68
17 - 24	2.75	2.77	2.78	2.68	2.62	2.60	2.66	2.67

HRS (MST)	YPENBURG	AUGUST						
1 - 8	2.73	2.77	2.82	2.81	2.84	2.85	2.30	2.29
9 - 16	2.56	2.65	2.64	2.71	2.70	2.81	2.71	2.52
17 - 24	2.66	2.57	2.41	2.30	2.34	2.42	2.45	2.60

HRS (MST)	YPENBURG	SEPTEMBER						
1 - 8	3.24	3.25	3.17	3.29	3.17	3.28	3.16	3.18
9 - 16	3.27	3.27	3.43	3.53	3.48	3.40	3.54	3.61
17 - 24	3.74	3.62	3.41	3.32	3.25	3.29	3.23	3.12

HRS (MST)	YPENBURG	OCTOBER						
1 - 8	3.58	3.54	3.61	3.56	3.57	3.63	3.57	3.49
9 - 16	3.35	3.28	3.43	3.72	3.63	3.78	3.97	3.95
17 - 24	3.70	3.34	3.45	3.46	3.54	3.69	3.59	3.59

HRS (MST)	YPENBURG	NOVEMBER						
1 - 8	3.68	3.74	3.95	3.89	[illegible]	3.89	4.02	3.97
9 - 16	4.24	4.30	4.42	4.56	4.4[illegible]	4.45	4.30	4.30
17 - 24	4.14	4.12	4.08	4.08	4.19	4.12	4.03	3.79

HRS (MST)	YPENBURG	DECEMBER						
1 - 8	3.48	3.37	3.37	3.34	3.29	3.30	3.28	3.16
9 - 16	3.29	3.62	3.91	3.95	4.05	3.96	3.81	3.81
17 - 24	3.77	3.68	3.69	3.68	3.62	3.55	3.42	3.4[illegible]

APPENDIX D

Range of Ypenburg RMS and RESMAX for Selected Curve Fits

10m Wind Speed

	RMS	HR	RMS	HR	RESMAX	HR	RESMAX	HR
JAN	.6	11	4.2	9	-.9	11	-7.8	9
FEB	1.2	4	4.3	20	-2.1	4	9.6	20
MAR	1.5	14	3.1	9	-2.6	8	-6.1	6
APR	.9	6	2.7	9	1.6	8	-6.4	18
MAY	1.0	16	3.8	12	-1.8	16	-9.3	12
JUN	1.3	2	6.3	13	-2.3	11	-13.9	13
JUL	.9	4	3.2	10	-2.3	20	6.0	11
AUG	.9	7	3.9	5	1.8	7	-7.8	18
SEP	1.1	2	3.0	10	2.1	2	-4.6	13
OCT	.9	5	3.4	14	-1.6	5	-7.0	16
NOV	1.5	16	4.0	23	-2.7	15	8.1	2
DEC	1.1	3	3.3	20	1.5	3	6.8	20

2m Wind Speed

RMS	HR	RMS	HR	RESMAX	HR	RESMAX	HR
.5	16	2.9	19	-.9	16	6.5	19
.2	19	1.9	21	.3	19	5.2	21
.6	7	2.5	3	1.1	1	5.6	3
.4	23	2.6	10	.7	4	5.3	10
0.0	2	7.2	24	0.0	3	7.6	24
.1	5	1.2	24	.4	5	2.7	14
.1	24	1.0	20	-.2	18	2.7	16
.1	20	1.7	13	.3	20	4.0	13
.1	22	1.2	13	.2	18	2.7	6
0.0	3	.6	1	.1	3	1.9	21
.4	14	2.2	19	.5	6	5.3	19
.4	2	2.2	6	.9	2	-4.0	6

Relative Humidity

	RMS	HR	RMS	HR	RESMAX	HR	RESMAX	HR
JAN	1.2	11	4.0	16	2.4	11	9.1	16
FEB	1.3	8	3.9	23	-2.2	5	-7.9	10
MAR	1.1	14	3.8	5	-1.9	14	7.4	5
APR	.8	20	5.2	8	-1.5	20	11.5	8
MAY	.6	12	3.0	24	-.9	12	6.0	22
JUN	.5	8	3.7	9	-1.0	8	-8.1	9
JUL	.9	21	5.0	5	-1.6	21	-13.3	5
AUG	1.0	11	5.1	5	-1.7	10	-12.7	4
SEP	.8	11	3.3	21	1.3	11	-6.4	21
OCT	1.6	15	5.4	1	-2.8	15	-14.5	1
NOV	1.5	4	3.6	14	2.5	2	-7.8	11
DEC	1.2	22	3.1	12	1.9	16	7.2	12

Sky Cover

RMS	HR	RMS	HR	RESMAX	HR	RESMAX	HR
2.0	8	5.7	11	3.8	8	-12.3	11
2.1	16	7.5	13	-3.5	8	-15.7	13
2.9	11	5.4	12	5.5	11	-11.4	13
4.0	10	8.9	13	-6.9	15	-15.7	13
4.2	15	8.3	8	-6.6	15	-16.7	8
4.7	14	8.0	8	8.8	14	-14.4	8
2.8	14	8.5	9	4.9	14	-12.2	9
2.2	8	4.8	10	-3.5	16	7.8	10
1.7	27	5.4	14	2.2	17	9.6	10
2.0	8	6.3	11	3.2	8	-11.6	11

Visual Attenuation

	RMS	HR	RMS	HR	RESMAX	HR	RESMAX	HR
JAN	2.3	17	5.1	16	7.5	11	13.5	15
FEB	1.5	10	3.1	7	3.6	2	-7.5	8
MAR	2.2	24	5.0	15	6.6	8	13.8	14
APR	2.9	5	5.8	21	11.2	5	22.5	19
MAY	2.2	7	4.8	22	5.4	6	16.9	18
JUN	1.9	7	4.8	14	7.0	7	11.7	19
JUL	2.0	7	4.5	18	7.7	8	20.5	18
AUG	2.1	3	5.4	11	7.6	6	16.8	8
SEP	2.1	7	6.6	15	7.7	7	31.8	15
OCT	1.9	2	4.7	15	7.3	2	18.1	16
NOV	3.0	8	6.3	15	12.1	8	27.8	15
DEC	2.4	9	4.6	14	7.9	10	15.7	20

Visual Extinction

RMS	HR	RMS	HR	RESMAX	HR	RESMAX	HR
1.8	17	3.6	4	-3.2	21	5.8	23
1.2	7	3.6	2	3.2	24	8.1	2
2.3	9	5.9	2	-4.6	9	-11.8	2
2.4	1	5.2	19	-4.8	4	-12.7	19
1.6	14	6.8	20	-3.9	13	-15.9	18
2.3	5	5.6	18	-5.2	5	-14.8	18
1.4	12	6.9	16	3.5	12	-16.8	16
1.3	18	4.8	21	-3.1	18	-11.1	12
1.9	9	7.0	15	-3.3	9	-14.4	15
1.0	23	5.0	17	-2.4	23	-10.1	17
2.4	14	5.5	10	-5.8	14	-11.9	16
1.1	22	4.6	8	3.3	22	-9.4	8

Equivalent Aerosol IR Extinction 8 - 12 Microns

	RMS	HR	RMS	HR	RESMAX	HR	RESMAX	HR
JAN	1.3	9	3.4	14	3.1	9	10.8	14
FEB	1.5	3	4.4	15	4.5	8	16.9	15
MAR	1.8	20	4.2	15	-6.5	3	-17.9	11
APR	1.1	22	3.6	9	2.8	2	-16.3	12
MAY	1.0	23	5.7	12	2.3	23	-26.8	12
JUN	1.4	24	4.6	17	2.9	23	-20.0	14
JUL	.7	22	5.1	13	1.5	22	-22.3	14
AUG	1.2	2	6.0	13	2.9	21	-28.0	13
SEP	1.0	6	6.4	12	-2.7	6	-27.3	14
OCT	1.0	19	3.5	15	-2.3	21	-12.5	14
NOV	1.8	15	3.7	13	-5.6	16	-16.7	13
DEC	1.6	20	3.2	14	-4.3	3	10.3	13

Equivalent Aerosol IR Extinction 3.4 - 5.0 Microns

RMS	HR	RMS	HR	RESMAX	HR	RESMAX	HR
1.1	18	2.2	4	-2.2	8	-6.0	3
1.3	23	2.9	14	3.0	23	9.1	15
.9	3	2.2	22	2.0	3	-7.3	12
1.0	3	2.1	12	2.2	20	-6.4	14
1.4	4	4.5	11	1.6	20	-17.1	11
1.1	22	3.3	16	-3.0	22	-10.4	16
.8	22	3.8	16	2.5	3	-15.3	14
.8	20	4.4	13	2.0	20	-17.3	14
.9	19	3.9	12	2.0	2	-15.8	13
.9	20	2.0	10	-1.8	19	7.5	11
1.4	9	3.5	14	11.8	14	11.8	11
1.0	10	2.0	11	-2.2	12	4.7	11

APPENDIX E

LINE SEGMENT FITTING

Figure E-1 shows the threshold and corresponding cumulative probabilities for a line segment fitting scheme. The cumulative probability represents the probability that the independent variable is less than or equal to the threshold; i.e., Pr $(X \leq x_T)$. The arrays contain both exterior boundaries; i. e., the thresholds for the cumulative probabilities of 0 and 100 percent. The total number of data points must be a multiple of the number of line segments desired:

$$NP \cdot NLS - 2 , \tag{E-1}$$

where NP is the number of points in each line segment, and NLS is the number of line segments. For example, if four points are to be used in each of three line segments, the total number of data points must be $(4 \cdot 3 - 2)$, or 10.

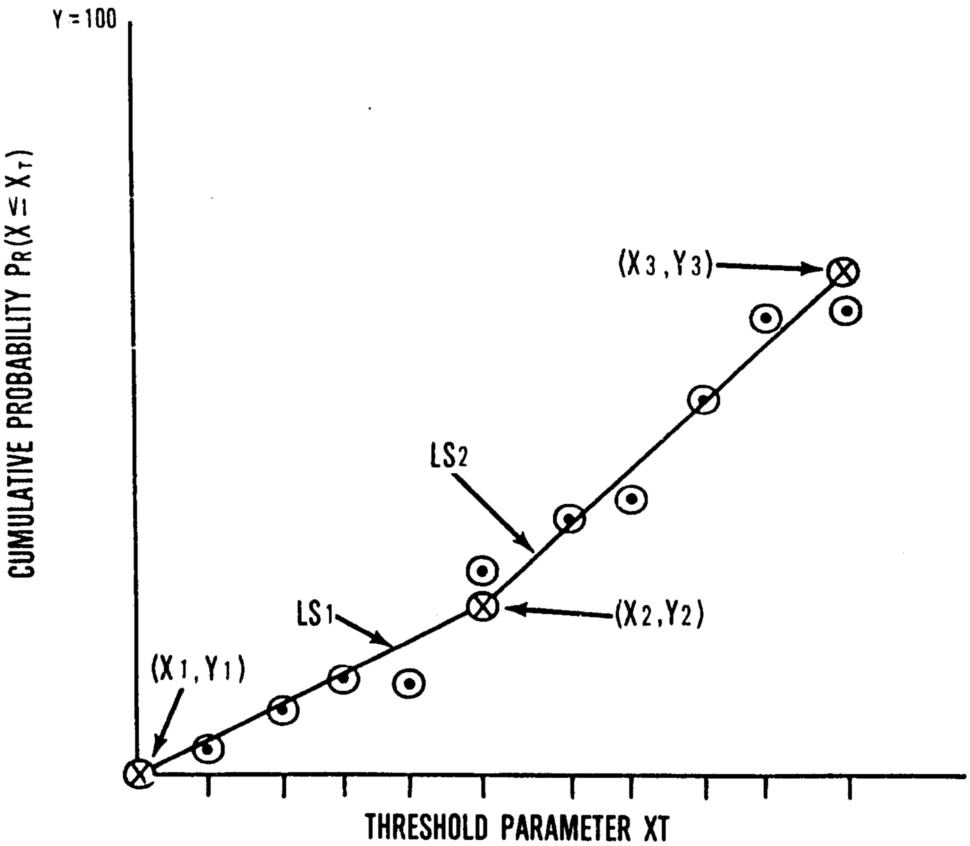

Figure E-1. Example of Line Segment Fitting for Three Line Segments (LS_1, LS_2, and LS_3) Passing Through the End Points (x_1, y_1), (x_2, y_2), and (x_3, y_3), Respectively.

Two line segments in Figure E-1 are to be fit across N_i data points. Only five data points are shown for clarity. The beginning of each line segment will pass through the point (x_i, y_i), which defines the line segment position and eventually the slope. Although the (x_i, y_i) points don't necessarily have to correspond with a threshoid, they are chosen this way to aid in storage of the final (x_i, y_i)'s for all line segments. The beginning and ending of the two line segments are defined by the two boundary conditions: the initial line segment LS_1 must pass through the zero percent CDF point (x_i, y_i), and both line segments must pass through (x_2, y_2).

Let a_1 and a_2 be the slopes of line segments LS_1 and LS_2, respectively, and let b_1 and b_2 be the y-intercepts of LS_1 and LS_2, respectively. For the two line segments, the equations for a straight line are:

$$y = a_1\, x + b_1 \tag{E-2a}$$

$$y = a_2\, x + b_2\ . \tag{E-2b}$$

Applying the boundary condition that the first two line segments must pass through (x_2,y_2), equations (E-2a) and (E-2b) become:

$$y = a_1\, (x - x_2) + y_2 \tag{E-3a}$$

$$y = a_2\, (x - x_2) + y_2\ . \tag{E-3b}$$

Now applying the boundary condition that LS_1 must pass through (x_1,y_1), the slope of LS_1 can be defined as:

$$a_1 = \frac{y_2 - y_1}{x_2 - x_1}\ . \tag{E-4}$$

Setting up the regression equations, the sum of the squares of errors (SSE) for the two line segments become $\underset{1}{\Sigma}$ and $\underset{2}{\Sigma}$ and are the summations over LS_1 and LS_2 respectively:

$$SSE_1 = \sum_1 (y_i - a_1(x_i - x_2) - y_2)^2 \tag{E-5a}$$

$$SSE_2 = \sum_1 (y_i - a_2(x_i - x_2) - y_2)^2\ . \tag{E-5b}$$

The total sum of the square of errors SSE_T is the sum of the SSEs over two line segments:

$$SSE_T = SSE_1 + SSE_2\ . \tag{E-6}$$

Following standard linear regression techniques, differentiate equation (E-6) first with respect to y_2 and then with respect to a_2, noting from equation (E-4) that a_1 is a function of y_2:

$$\frac{\partial SSE_T}{\partial y_2} = -2 \sum_1 (y_i - a_1(x_i - x_2) - y_2)\left(\frac{x_i - x_2}{x_2 - x_1}\right) - 2 \Sigma\, (y_i - a_2(x_i - x_2) - y_2) \tag{E-7}$$

$$\frac{\partial SSE_T}{\partial a_2} = -2\left(\sum_2 (y_i - a_2(x_i - x_2)\right)(x_i - x_2)\ . \tag{E-8}$$

Setting equations (E-7) and (E-8) to zero,

$$\sum_1 (y_i - a_1(x_i - x_2) - y_2)\left(\frac{x_i - x_2}{x_2 - x_1} + 1\right) + \sum_2 (y_i - a_2(x_i - x_2) - y_2) = 0 \tag{E-9}$$

$$\sum_2 y_i(x - x_2) - a_2 \sum_2 (x_i - x_2)^2 - y_2 \sum_2 (x_i - x_2) = 0\ . \tag{E-10}$$

Solving for a_2 in equation (E-10) gives:

$$a_2 = \frac{\sum_2 Y_i(x_i - x_2) - y_2 \sum_2 (x_i - x_2)}{\sum_2 (x_i - x_2)^2}\ . \tag{E-11}$$

To make the derivation somewhat easier, the following simplifying substitutions are defined:

$$A1 = \sum_1 y_i \qquad A2 = \sum_2 y_i$$

$$B1 = \sum_1 (x_i - x_2)y_i \qquad B2 = \sum_2 (x_i - x_2)y_i$$

$$C1 = \sum_1 (x_i - x_2) \qquad C2 = \sum_2 (x_i - x_2)$$

$$D1 = \sum_1 (x_i - x_2)^2 \qquad D2 = \sum_2 (x_i - x_2)^2$$

$$N_1 y_1 = \sum_1 y_1 \qquad N_2 y_2 = \sum_2 y_2$$

$$E = (x_2 - x_1) .$$

Using these substitutions, equations (E-4) and (E-11) become:

$$a_1 = \frac{y_2 - y_1}{E} \quad \text{and} \quad a_2 = \frac{B2 - y_2 C2}{D2} . \tag{E-12}$$

Substituting a_1 and a_2 from equation (E-12) into equation (E-9) gives:

$$\frac{1}{E}\left[B1 - \frac{(y_2 - y_1)\, D1}{E} - y_2 C1\right] + \left[A1 - \frac{(y_2 - y_1)\, C1}{E} - N_1 y_2\right] + A2 - \frac{B2 - y_2 C2}{D2} - N_2 y_2 = 0 . \tag{E-13}$$

Solving equation (E-13) for y_2 gives:

$$y_2 = \frac{A1 + A2 + \frac{B1}{E} - \frac{B2 \cdot C2}{D2} + \frac{Y_1}{E} \cdot \left(\frac{D1}{E} + C1\right)}{\frac{D1}{E \cdot E} + 2\,\frac{C1}{E} - \frac{C2 \cdot C2}{D2} + N_1 + N_2} . \tag{E-14}$$

Since the point x_2 falls on an observed threshold that is used in fitting both line segments, the error at this point is counted twice. The contribution of one these errors must be subtracted from y_2. Let y be the observation at x_2. The squared error at x_2 is $(y - y_2)^2$ and the corrected sum of the squared errors becomes:

$$SSE_T = SSE_T \text{ (uncorrected)} - (\hat{y} - y_2)^2 . \tag{E-15}$$

This correction term shows up only in the partial differentiation with respect to y_2 (see equation E-7):

$$\frac{\partial}{\partial y_2} (\hat{y} - y_2)^2 = 2\, (\hat{y} - y_2) . \tag{E-16}$$

Therefore,

$$\frac{\partial}{\partial y_2} SSE_T \text{ (corrected)} = \frac{\partial}{\partial y_2} SSE_T \text{ (uncorrected)} + 2\, (\hat{y} - y_2) . \tag{E-17}$$

Applying this correction term to equation (E-14), the corrected y-value for the line segment becomes:

$$y_2 = \frac{A1 + A2 + \frac{B1}{E} - \frac{B2 \cdot C2}{D2} + \frac{y_1}{E} \cdot \left(\frac{D1}{E} + C1 \right) - \hat{y}}{\frac{D1^2}{E} + 2\,\frac{C1}{E} - \frac{(C2)^2}{D2} + N_1 + N_2 - 1} , \qquad \text{(E-18)}$$

where N_1 and N_2 are the number of data points in line segment fits LS_1 and LS_2, respectively.

APPENDIX F

EFFECT OF OBSERVATION ERROR IN CORRELATION

Brooks and Carruthers (1953) expand the basic correlation equation to show that the actual correlation is larger than the correlation derived from the measured data. With certain assumptions, correlations derived from observed data can be significantly improved.

Let X and Y be two measured variables, let x and y be the deviations of X and Y from their mean values, let N be the number of pairs of observations, and let σ_x, σ_y be the standard deviations of the X and Y series. If d and e are random errors of observation of X and Y, respectively, the deviations of the observed values from their means can be written:

$$\alpha = x + d \qquad\qquad \beta = y + e \,. \tag{F-1}$$

The correlation coefficient between two variables X and Y is:

$$r_{xy} = \frac{\Sigma[(X_i - \bar{X})\,(Y_i - \bar{Y})]}{\sqrt{\Sigma(X_i - \bar{X})^2}\,\sqrt{\Sigma(Y_i - \bar{Y})^2}}\,, \tag{F-2}$$

which can also be written:

$$r_{xy} = \frac{\Sigma\, XY - N\bar{X}\bar{Y}}{N\,\sigma_x\,\sigma_y}\,. \tag{F-3}$$

Substituting the equations for α and β (equation 5-1-1) into equation 5-1-3,

$$r_{\alpha\beta} = \frac{\Sigma\,\alpha_\beta}{N\,\sigma_\alpha\,\sigma_\beta} = \frac{\Sigma\,[(x + d)\,(y + e)] - N\,\overline{(x + d)}\,\overline{(y + e)}}{N\,\sigma_\alpha\,\sigma_\beta}\,. \tag{F-4}$$

In expanded form the numerator becomes,

$$\Sigma xy + \Sigma xe + \Sigma dy + \Sigma de - N[\bar{x}\bar{y} + \bar{x}\bar{e} + \bar{d}\bar{y} + \bar{d}\bar{e}]\,. \tag{F-5}$$

Rearranging terms in equation (F-5),

$$(\Sigma xy - N\bar{x}\bar{y}) + (\Sigma xe - N\bar{x}\bar{e}) + (\Sigma dy - N\bar{d}\bar{y}) + (\Sigma de - N\,\bar{d}\bar{e})\,. \tag{F-6}$$

From the definition of the correlation coefficient in equation (F-3), each of the terms in equation (F-6) can be written in the form:

$$N r_{xy}\,\sigma_x\sigma_y = \Sigma xy - N\bar{x}\bar{y}\,. \tag{F-7}$$

Using the format of equation (F-7) for each of the terms in equation (F-6), the numerator becomes:

$$N r_{xy}\,\sigma_x\sigma_y = N r_{xe}\sigma_x\sigma_e + N r_{dy}\,\sigma_d\,\sigma_y + N r_{de}\,\sigma_d\,\sigma_e\,. \tag{F-8}$$

Inserting the numerator (equation F-8) back into equation (F-4),

$$r_{\alpha\beta} = \frac{N r_{xy}\,\sigma_x\sigma_y + N r_{xe}\sigma_x\sigma_e + N r_{dy}\,\sigma_d\sigma_y + N r_{de}\,\sigma_d\,\sigma_e}{N\sigma_\alpha\,\sigma_\beta}\,. \tag{F-9}$$

If we assume that the random errors d and e are entirely independent of each other and of X and Y, the correlation terms involving d and e become zero:

$$r_{xy} = \frac{\sigma_\alpha \sigma_\beta}{\sigma_x \sigma_y} r_{\alpha\beta} \quad , \tag{F-10}$$

where

$$\sigma_\alpha^2 = \sigma_x^2 + \sigma_d^2$$

$$\sigma_\beta^2 = \sigma_y^2 + \sigma_e^2 \ .$$

Therefore, the actual correlation between two variables is larger than the correlation derived from the measured values. Furthermore, a quantitative estimate of the actual correlation is possible where the assumption that the random errors of observation are entirely independent of each other holds.

APPENDIX G

YPENBURG SERIAL CORRELATION COEFFICIENTS

SERIAL CORRELATION COEFFICIENTS AND EXPONENTIAL DECAY FUNCTIONS
YPENBURG VISUAL ATTENUATION (PER KM)

JANUARY

	HR 1	HR 2	HR 3	HR 6	HR 9	HR 12	HR 18	HR 24
OVERALL	0.9407	0.8923	0.8562	0.7615	0.6809	0.6249	0.5029	0.4072
YEAR 1	0.9394	0.8923	0.8582	0.7405	0.6123	0.5292	0.4081	0.3135
	703	700	696	687	681	675	666	661
YEAR 2	0.9179	0.8629	0.8170	0.7250	0.6530	0.5854	0.4339	0.3096
	731	730	729	726	723	721	715	709
YEAR 3	0.9287	0.8669	0.8214	0.6881	0.5800	0.5346	0.3848	0.2772
	743	742	717	738	735	732	726	720
YEAR 4	0.9490	0.8998	0.8658	0.7803	0.7129	0.6546	0.5332	0.4344
	716	715	714	711	708	705	699	693
FISHZ	0.9346	0.8812	0.8417	0.7347	0.6421	0.5784	0.4417	0.3347
LINEAR REG	0.9239	0.8842	0.8462	0.7416	0.6500	0.5697	0.4376	0.3362

TOT NUM OBS 1HR COR 2893

FEBRUARY

	HR 1	HR 2	HR 3	HR 6	HR 9	HR 12	HR 18	HR 24
OVERALL	0.9461	0.8923	0.8396	0.6996	0.5883	0.5112	0.4036	0.3507
YEAR 1	0.9339	0.8628	0.8044	0.6539	0.5589	0.4779	0.3556	0.1828
	633	629	627	619	613	608	597	587
YEAR 2	0.9516	0.8960	0.8428	0.6854	0.5346	0.4340	0.2821	0.2247
	628	626	624	618	612	606	594	582
YEAR 3	0.9166	0.8501	0.7787	0.6140	0.4927	0.4042	0.2533	0.2417
	693	692	627	688	685	682	676	670
YEAR 4	0.9694	0.9352	0.8978	0.7986	0.7280	0.6809	0.6518	0.6275
	630	629	628	625	622	619	613	607
FISHZ	0.9459	0.8903	0.8370	0.6934	0.5848	0.5068	0.3986	0.3357
LINEAR REG	0.9232	0.8783	0.8356	0.7194	0.6194	0.5332	0.3953	0.2930

TOT NUM OBS 1HR COR 2584

MARCH

	HR 1	HR 2	HR 3	HR 6	HR 9	HR 12	HR 18	HR 24
OVERALL	0.9307	0.8722	0.8258	0.7015	0.6109	0.5315	0.4232	0.3534
YEAR 1	0.9388	0.8962	0.8550	0.7666	0.6879	0.6050	0.5024	0.3973
	550	539	528	495	481	487	472	523
YEAR 2	0.8965	0.8082	0.7504	0.3538	0.4344	0.3341	0.1965	0.0843
	586	583	577	567	559	552	536	518
YEAR 3	0.9393	0.8654	0.8195	0.7027	0.6077	0.5451	0.4110	0.3727
	737	735	737	730	727	724	719	712
YEAR 4	0.9287	0.8666	0.8109	0.6645	0.5600	0.4631	0.3567	0.2855
	743	742	741	738	735	732	726	720
FISHZ	0.9254	0.8620	0.8116	0.6768	0.5764	0.4901	0.3699	0.2958
LINEAR REG	0.9056	0.8588	0.8145	0.6947	0.5925	0.5054	0.3677	0.2675

TOT NUM OBS 1HR COR 2618

APRIL

	HR 1	HR 2	HR 3	HR 6	HR 9	HR 12	HR 18	HR 24
OVERALL	0.9315	0.8657	0.8064	0.6630	0.5490	0.4731	0.4064	0.3422
YEAR 1	0.9369	0.8516	0.7765	0.6216	0.5148	0.4163	0.2888	0.2151
	565	563	561	555	549	543	531	519
YEAR 2	0.9358	0.8823	0.8285	0.6758	0.5483	0.4498	0.3523	0.2606
	717	716	715	712	709	706	700	694
YEAR 3	0.8962	0.7856	0.6901	0.4849	0.3081	0.2311	0.2426	0.1719
	717	716	716	712	709	706	700	694
YEAR 4	0.9381	0.8845	0.8418	0.7311	0.6508	0.5932	0.5042	0.4687
	719	718	717	714	711	708	702	696
FISHZ	0.9266	0.8586	0.7917	0.6374	0.5156	0.4322	0.3554	0.2885
LINEAR REG	0.8930	0.8431	0.7961	0.6701	0.5541	0.4749	0.3365	0.2384

TOT NUM OBS 1HR COR 2719

SERIAL CORRELATION COEFFICIENTS AND EXPONENTIAL DECAY FUNCTIONS
YPENBURG VISUAL ATTENUATION (PER KM)

MAY

	HR 1	HR 2	HR 3	HR 6	HR 9	HR 12	HR 18	HR 24
OVERALL	0.9321	0.8670	0.8066	0.6621	0.5795	0.5374	0.5023	0.4754
YEAR 1	0.9092	0.8148	0.7383	0.5363	0.4297	0.4091	0.3847	0.3845
	656	655	654	651	648	645	639	633
YEAR 2	0.9271	0.8432	0.7559	0.5713	0.4514	0.3850	0.3595	0.3272
	625	623	621	615	609	603	591	579
YEAR 3	0.9067	0.8234	0.7584	0.5919	0.5169	0.4713	0.4191	0.3712
	739	738	735	734	731	728	722	716
YEAR 4	0.9458	0.8831	0.8164	0.6509	0.5174	0.4428	0.3771	0.3574
	738	736	734	730	727	724	718	712
FISHZ	0.9229	0.8441	0.7704	0.5915	0.4825	0.4301	0.3866	0.3612
LINEAR REG	0.8590	0.8180	0.7788	0.6724	0.5805	0.5011	0.3735	0.2783

TOT NUM OBS 1HR COR 2758

JUNE

	HR 1	HR 2	HR 3	HR 6	HR 9	HR 12	HR 18	HR 24
OVERALL	0.9062	0.8313	0.7664	0.5960	0.4905	0.4322	0.3224	0.2518
YEAR 1	0.9045	0.8098	0.7156	0.4967	0.3780	0.3177	0.2472	0.2469
	717	716	715	712	709	706	700	694
YEAR 2	0.8692	0.7907	0.7328	0.5689	0.4995	0.4916	0.4161	0.3249
	423	420	417	408	399	390	373	355
YEAR 3	0.9299	0.8669	0.8130	0.6675	0.5446	0.4538	0.2898	0.2016
	621	621	618	609	600	591	573	557
YEAR 4	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0	0	0	0	0	0	0	0
FISHZ	0.9076	0.8282	0.7578	0.5788	0.4681	0.4083	0.3018	0.2489
LINEAR REG	0.8704	0.8158	0.7647	0.6297	0.5185	0.4270	0.2895	0.1963

TOT NUM OBS 1HR COR 1764

JULY

	HR 1	HR 2	HR 3	HR 6	HR 9	HR 12	HR 18	HR 24
OVERALL	0.9224	0.8421	0.7647	0.5897	0.4694	0.3694	0.2795	0.2050
YEAR 1	0.9313	0.8574	0.7940	0.6591	0.5672	0.5135	0.4268	0.3812
	743	742	741	738	735	732	726	720
YEAR 2	0.8997	0.7930	0.6893	0.5089	0.4046	0.2725	0.1608	0.0542
	617	614	611	601	592	583	565	547
YEAR 3	0.9332	0.8605	0.7850	0.5766	0.4289	0.3106	0.2182	0.1157
	741	740	701	736	733	730	724	718
YEAR 4	0.9099	0.8249	0.7440	0.5660	0.4412	0.3449	0.2639	0.2114
	702	699	696	687	678	669	656	644
FISHZ	0.9207	0.8378	0.7585	0.5838	0.4665	0.3698	0.2773	0.2027
LINEAR REG	0.8920	0.8287	0.7698	0.6171	0.4948	0.3966	0.2549	0.1638

TOT NUM OBS 1HR COR 2803

AUGUST

	HR 1	HR 2	HR 3	HR 6	HR 9	HR 12	HR 18	HR 24
OVERALL	0.9362	0.8732	0.8164	0.6840	0.5870	0.5169	0.4392	0.3654
YEAR 1	0.9215	0.8384	0.7553	0.5343	0.3945	0.3429	0.3332	0.3233
	681	678	676	670	664	658	646	634
YEAR 2	0.8915	0.8140	0.7522	0.5910	0.4614	0.3800	0.2745	0.2097
	525	521	517	505	494	483	470	464
YEAR 3	0.9258	0.8400	0.7679	0.6325	0.5391	0.4921	0.3808	0.2638
	649	646	640	634	625	616	604	592
YEAR 4	0.9438	0.8898	0.8390	0.7196	0.6169	0.4862	0.3347	0.2522
	732	730	728	722	716	712	706	700
FISHZ	0.9247	0.8510	0.7847	0.6284	0.5128	0.4310	0.3481	0.2661
LINEAR REG	0.8922	0.8406	0.7919	0.6622	0.5537	0.4530	0.3237	0.2263

TOT NUM OBS 1HR COR 2587

SERIAL CORRELATION COEFFICIENTS AND EXPONENTIAL DECAY FUNCTIONS
YPENBURG VISUAL ATTENUATION (PER KM)

SEPTEMBER

	HR 1	HR 2	HR 3	HR 6	HR 9	HR 12	HR 18	HR 24
OVERALL	0.9295	0.8647	0.8023	0.6513	0.5123	0.4271	0.3476	0.2778
YEAR 1	0.9162	0.8334	0.7568	0.5329	0.3182	0.1691	0.0540	0.0946
	443	442	441	438	435	432	426	420
YEAR 2	0.8925	0.8187	0.7517	0.5908	0.4457	0.3732	0.2772	0.2285
	675	673	671	665	659	653	641	632
YEAR 3	0.9285	0.8463	0.7648	0.5637	0.3742	0.2517	0.1341	0.0253
	632	626	638	605	595	593	585	576
YEAR 4	0.9405	0.8857	0.8315	0.7077	0.5966	0.5268	0.4697	0.3728
	719	718	717	714	711	708	702	696
FISHZ	0.9220	0.8502	0.7817	0.6129	0.4564	0.3593	0.2664	0.2013
LINEAR REG	0.9080	0.8418	0.7804	0.6219	0.4956	0.3950	0.2508	0.1593

TOT NUM OBS 1HR COR 2469

OCTOBER

	HR 1	HR 2	HR 3	HR 6	HR 9	HR 12	HR 18	HR 24
OVERALL	0.9526	0.9119	0.8739	0.7749	0.6925	0.6408	0.5507	0.5105
YEAR 1	0.9258	0.8534	0.7889	0.6031	0.5061	0.4588	0.3962	0.4125
	581	579	577	571	565	559	547	537
YEAR 2	0.9656	0.9341	0.9010	0.8072	0.7054	0.6349	0.5177	0.4394
	708	707	706	703	700	697	691	685
YEAR 3	0.9242	0.8553	0.7933	0.6616	0.5479	0.4886	0.3734	0.3476
	696	693	699	682	673	664	647	637
YEAR 4	0.9150	0.8595	0.8091	0.6769	0.5559	0.4666	0.2893	0.1932
	743	742	741	738	735	732	726	720
FISHZ	0.9365	0.8823	0.8315	0.6997	0.5883	0.5189	0.3965	0.3458
LINEAR REG	0.9151	0.8721	0.8310	0.7192	0.6225	0.5387	0.4035	0.3022

TOT NUM OBS 1HR COR 2728

NOVEMBER

	HR 1	HR 2	HR 3	HR 6	HR 9	HR 12	HR 18	HR 24
OVERALL	0.9490	0.9079	0.8702	0.7786	0.7160	0.6658	0.5878	0.5461
YEAR 1	0.9196	0.8693	0.8285	0.7113	0.6194	0.5615	0.4765	0.3926
	719	718	717	714	711	708	702	696
YEAR 2	0.9661	0.9374	0.9139	0.8622	0.8286	0.7945	0.7351	0.6846
	717	716	715	712	709	706	700	694
YEAR 3	0.9125	0.8437	0.7696	0.5752	0.4375	0.3391	0.2232	0.2215
	717	716	621	712	709	706	700	694
YEAR 4	0.9321	0.8633	0.8020	0.6672	0.5856	0.5122	0.3680	0.3012
	619	613	607	594	583	575	562	559
FISHZ	0.9366	0.8854	0.8413	0.7249	0.6447	0.5809	0.4813	0.4253
LINEAR REG	0.9078	0.8747	0.8428	0.7540	0.6745	0.6033	0.4828	0.3864

TOT NUM OBS 1HR COR 2772

DECEMBER

	HR 1	HR 2	HR 3	HR 6	HR 9	HR 12	HR 18	HR 24
OVERALL	0.9410	0.8911	0.8424	0.7208	0.6248	0.5589	0.5110	0.4879
YEAR 1	0.9628	0.9267	0.8880	0.7715	0.6698	0.6006	0.6037	0.6177
	552	549	546	537	528	519	501	484
YEAR 2	0.9663	0.9379	0.9147	0.8620	0.8279	0.7935	0.7345	0.6839
	693	692	691	688	685	682	676	670
YEAR 3	0.9125	0.8426	0.7824	0.6390	0.5213	0.4269	0.3412	0.3157
	743	742	728	738	735	732	726	720
YEAR 4	0.9075	0.8275	0.7433	0.5405	0.4128	0.3200	0.2206	0.1435
	728	725	723	717	711	706	700	694
FISHZ	0.9413	0.8904	0.8423	0.7208	0.6306	0.5587	0.4912	0.4500
LINEAR REG	0.9645	0.8725	0.8415	0.7552	0.6778	0.6082	0.4899	0.3945

TOT NUM OBS 1HR COR 2716

SERIAL CORRELATION COEFFICIENTS AND EXPONENTIAL DECAY FUNCTIONS
YPENBURG VISUAL EXTINCTION (PER KM)

JANUARY

	HR 1	HR 2	HR 3	HR 6	HR 9	HR 12	HR 18	HR 24
OVERALL	0.8892	0.8366	0.7958	0.6944	0.6231	0.5823	0.4717	0.3728
YEAR 1	0.8990	0.8517	0.8115	0.6987	0.5775	0.4977	0.3616	0.2681
	703	700	696	687	681	675	666	661
YEAR 2	0.8669	0.8011	0.7356	0.6374	0.5658	0.5070	0.3553	0.2402
	717	714	714	710	707	705	699	693
YEAR 3	0.9031	0.8299	0.7796	0.6538	0.5449	0.4940	0.3291	0.2215
	714	712	710	704	698	692	680	668
YEAR 4	0.8556	0.7995	0.7624	0.6430	0.5876	0.5638	0.4748	0.3565
	716	715	714	711	708	705	699	693
FISHZ	0.8827	0.8216	0.7735	0.6586	0.5692	0.5165	0.3823	0.2729
LINEAR REG	0.8648	0.8230	0.7833	0.6751	0.5819	0.5015	0.3726	0.2768

TOT NUM OBS 1HR COR 2850

FEBRUARY

	HR 1	HR 2	HR 3	HR 6	HR 9	HR 12	HR 18	HR 24
OVERALL	0.9222	0.8638	0.8094	0.6564	0.5553	0.4739	0.3689	0.3137
YEAR 1	0.9154	0.8384	0.7668	0.5918	0.4894	0.4172	0.2800	0.0711
	580	575	572	561	552	544	527	511
YEAR 2	0.9343	0.8834	0.8248	0.6682	0.5584	0.4612	0.2869	0.2462
	623	621	619	613	607	601	589	577
YEAR 3	0.9091	0.8412	0.7781	0.6012	0.4654	0.3502	0.2027	0.2063
	693	692	691	688	685	682	676	670
YEAR 4	0.9215	0.8851	0.8524	0.7433	0.6821	0.6342	0.6463	0.6249
	630	629	628	625	622	619	613	607
FISHZ	0.9204	0.8636	0.8085	0.6558	0.5547	0.4721	0.3706	0.3119
LINEAR REG	0.8964	0.8504	0.8067	0.6886	0.5878	0.5018	0.3657	0.2665

TOT NUM OBS 1HR COR 2526

MARCH

	HR 1	HR 2	HR 3	HR 6	HR 9	HR 12	HR 18	HR 24
OVERALL	0.8857	0.8160	0.7754	0.6373	0.5248	0.4433	0.3582	0.2972
YEAR 1	0.8731	0.7978	0.7714	0.6511	0.5318	0.4163	0.3253	0.2552
	647	644	644	634	625	616	599	585
YEAR 2	0.7945	0.7010	0.6245	0.4303	0.2634	0.1932	0.1594	0.0074
	457	451	446	432	421	411	389	372
YEAR 3	0.8831	0.7937	0.7446	0.5894	0.4962	0.4332	0.3088	0.2738
	702	699	696	691	685	680	671	664
YEAR 4	0.9021	0.8406	0.7962	0.6394	0.5065	0.4117	0.3178	0.2569
	741	740	739	736	733	730	724	718
FISHZ	0.8743	0.7961	0.7504	0.5971	0.4729	0.3848	0.2923	0.2232
LINEAR REG	0.8520	0.7977	0.7469	0.6131	0.5033	0.4131	0.2783	0.1875

TOT NUM OBS 1HR COR 2547

APRIL

	HR 1	HR 2	HR 3	HR 6	HR 9	HR 12	HR 18	HR 24
OVERALL	0.8785	0.8610	0.7382	0.5764	0.4589	0.4118	0.3589	0.2990
YEAR 1	0.8158	0.7030	0.5986	0.3766	0.2642	0.2399	0.1994	0.1435
	551	547	545	536	530	526	518	506
YEAR 2	0.9030	0.8387	0.7778	0.5988	0.4552	0.3593	0.2795	0.2265
	713	711	709	706	703	700	694	688
YEAR 3	0.8330	0.7146	0.6133	0.4074	0.2406	0.1988	0.1842	0.1229
	715	714	713	710	707	704	698	692
YEAR 4	0.8587	0.7798	0.7448	0.6063	0.4965	0.4724	0.3891	0.2736
	382	380	378	372	366	360	349	337
FISHZ	0.8585	0.7666	0.6895	0.4975	0.3571	0.3038	0.2501	0.1831
LINEAR REG	0.8185	0.7558	0.6979	0.5495	0.4327	0.3407	0.2112	0.1309

TOT NUM OBS 1HR COR 2361

SERIAL CORRELATION COEFFICIENTS AND EXPONENTIAL DECAY FUNCTIONS
YPENBURG VISUAL EXTINCTION (PER KM)

MAY

	HR 1	HR 2	HR 3	HR 6	HR 9	HR 12	HR 18	HR 24
OVERALL	0.8857	0.8240	0.7565	0.6082	0.5332	0.4975	0.4663	0.4323
YEAR 1	0.7903	0.7264	0.6013	0.3185	0.2055	0.2251	0.0937	0.1605
	546	544	542	536	530	524	512	500
YEAR 2	0.8951	0.8221	0.7383	0.5854	0.5140	0.4401	0.3875	0.3019
	549	545	541	530	518	506	487	474
YEAR 3	0.8601	0.7775	0.6940	0.5101	0.4181	0.3785	0.3696	0.3078
	735	734	733	730	727	724	718	712
YEAR 4	0.8616	0.7877	0.7278	0.5554	0.4317	0.3685	0.3575	0.3704
	738	736	734	730	727	724	718	712
FISHZ	0.8568	0.7800	0.6966	0.5038	0.4015	0.3577	0.3151	0.2962
LINEAR REG	0.7957	0.7514	0.7096	0.5976	0.5033	0.4239	0.3006	0.2132

TOT NUM OBS 1HR COR 2568

JUNE

	HR 1	HR 2	HR 3	HR 6	HR 9	HR 12	HR 18	HR 24
OVERALL	0.8355	0.7310	0.6505	0.4838	0.4179	0.3689	0.2704	0.2153
YEAR 1	0.8142	0.6948	0.5919	0.3897	0.3545	0.3367	0.1678	0.1493
	715	714	713	[illegible]	707	704	698	692
YEAR 2	0.7857	0.6718	0.5882	0.4580	0.3894	0.3081	0.2984	0.2304
	407	404	399	387	375	364	349	331
YEAR 3	0.8833	0.7995	0.7420	0.6023	0.5189	0.4657	0.3769	0.2884
	511	503	495	476	462	448	431	418
YEAR 4	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0	0	0	0	0	0	0	0
FISHZ	0.8331	0.7263	0.6432	0.4763	0.4149	0.3698	0.2619	0.2090
LINEAR REG	0.7739	0.7234	0.6762	0.5523	0.4512	0.3685	0.2459	0.1640

TOT NUM OBS 1HR COR 1633

JULY

	HR 1	HR 2	HR 3	HR 6	HR 9	HR 12	HR 18	HR 24
OVERALL	0.8777	0.7942	0.7278	0.5528	0.4450	0.3558	0.2362	0.1803
YEAR 1	0.8329	0.7112	0.6335	0.4917	0.4283	0.3618	0.2861	0.2686
	741	740	739	736	733	730	724	718
YEAR 2	0.8271	0.7537	0.6971	0.5449	0.4419	0.3674	0.1871	0.1339
	373	370	367	357	348	339	321	303
YEAR 3	0.9111	0.8421	0.7746	0.5785	0.4540	0.3538	0.2039	0.0527
	602	600	599	596	593	590	584	578
YEAR 4	0.8640	0.7621	0.6824	0.4548	0.31[illegible]	0.1912	0.0793	0.1039
	543	540	537	528	[illegible]	510	492	474
FISHZ	0.8645	0.7706	0.6976	0.5164	0.4117	0.3220	0.2017	0.1525
LINEAR REG	0.8390	0.7704	0.7074	0.5477	0.4241	0.3283	0.1968	0.1180

TOT NUM OBS 1HR COR 2259

AUGUST

	HR 1	HR 2	HR 3	HR 6	HR 9	HR 12	HR 18	HR 24
OVERALL	0.8776	0.7923	0.7370	0.6135	0.5272	0.4569	0.3484	0.2643
YEAR 1	0.8980	0.8309	0.7763	0.6000	0.4689	0.3831	0.3630	0.2299
	617	608	602	587	574	563	548	539
YEAR 2	0.8273	0.7269	0.6821	0.5344	0.4320	0.3776	0.2818	0.1545
	511	506	502	491	480	468	458	452
YEAR 3	0.8672	0.7566	0.6801	0.5635	0.4847	0.4406	0.3254	0.2417
	621	618	615	606	597	588	570	552
YEAR 4	0.8636	0.7731	0.7191	0.6076	0.5328	0.4360	0.2602	0.1923
	743	742	741	738	735	732	726	720
FISHZ	0.8675	0.7765	0.7181	0.5806	0.4860	0.4133	0.3057	0.2060
LINEAR REG	0.8334	0.7823	0.7343	0.6072	0.5022	0.4153	0.2840	0.1942

TOT NUM OBS 1HR COR 2492

SERIAL CORRELATION COEFFICIENTS AND EXPONENTIAL DECAY FUNCTIONS
YPENBURG VISUAL EXTINCTION (PER KM)

SEPTEMBER

	HR 1	HR 2	HR 3	HR 6	HR 9	HR 12	HR 18	HR 24
OVERALL	0.8927	0.8342	0.7939	0.6794	0.5771	0.5326	0.4401	0.3654
YEAR 1	0.6538	0.5760	0.5812	0.4607	0.2437	0.2144	0.0035	0.0210
	367	365	365	362	359	356	350	344
YEAR 2	0.8603	0.7874	0.7325	0.5822	0.4987	0.4752	0.3455	0.2665
	656	652	648	639	630	622	610	600
YEAR 3	0.9069	0.8273	0.7573	0.6006	0.4442	0.3551	0.2632	0.1564
	662	659	656	647	638	629	611	593
YEAR 4	0.9299	0.8699	0.8170	0.6796	0.5504	0.4612	0.3509	0.2147
	310	308	306	300	294	288	276	264
FISHZ	0.8688	0.7892	0.7333	0.5844	0.4458	0.3882	0.2578	0.1771
LINEAR REG	0.8517	0.7921	0.7366	0.5924	0.4765	0.3832	0.2479	0.1604

TOT NUM OBS 1HR COR 1995

OCTOBER

	HR 1	HR 2	HR 3	HR 6	HR 9	HR 12	HR 18	HR 24
OVERALL	0.9243	0.8721	0.8277	0.7252	0.6506	0.5952	0.5066	0.4617
YEAR 1	0.9217	0.8730	0.8332	0.7366	0.6736	0.6150	0.5257	0.5097
	489	486	483	474	466	460	448	437
YEAR 2	0.9397	0.9000	0.8521	0.7231	0.6102	0.5361	0.4246	0.3595
	698	696	694	688	684	681	675	669
YEAR 3	0.8953	0.7960	0.7283	0.6066	0.5073	0.4407	0.3579	0.3461
	692	689	687	678	669	661	642	632
YEAR 4	0.8618	0.7805	0.7168	0.5688	0.4906	0.4248	0.2887	0.1868
	743	742	741	738	735	732	726	720
FISHZ	0.9071	0.8415	0.7853	0.6568	0.5649	0.4971	0.3892	0.3368
LINEAR REG	0.8729	0.8325	0.7939	0.6885	0.5972	0.5179	0.3896	0.2930

TOT NUM OBS 1HR COR 2622

NOVEMBER

	HR 1	HR 2	HR 3	HR 6	HR 9	HR 12	HR 18	HR 24
OVERALL	0.9097	0.8672	0.8227	0.7199	0.6559	0.6096	0.5581	0.5140
YEAR 1	0.8367	0.7499	0.6967	0.5179	0.4173	0.4030	0.3306	0.2054
	714	712	711	708	705	703	698	692
YEAR 2	0.9474	0.9234	0.8989	0.8487	0.8172	0.7853	0.7499	0.6879
	701	700	699	697	693	690	684	678
YEAR 3	0.8760	0.8005	0.7017	0.4602	0.3436	0.2522	0.2003	0.2185
	717	716	715	712	709	706	700	694
YEAR 4	0.8599	0.8108	0.7554	0.6340	0.5513	0.4812	0.3888	0.3391
	696	694	692	686	680	674	662	652
FISHZ	0.8887	0.8342	0.7796	0.6481	0.5652	0.5116	0.4468	0.3845
LINEAR REG	0.8488	0.8156	0.7836	0.6952	0.6167	0.5471	0.4306	0.3389

TOT NUM OBS 1HR COR 2828

DECEMBER

	HR 1	HR 2	HR 3	HR 6	HR 9	HR 12	HR 18	HR 24
OVERALL	0.8894	0.8236	0.7681	0.6280	0.5271	0.4675	0.4264	0.4098
YEAR 1	0.9334	0.8970	0.8545	0.7441	0.6388	0.5886	0.6152	0.6316
	574	572	570	564	558	552	540	528
YEAR 2	0.9473	0.9238	0.8998	0.8483	0.8156	0.7838	0.7497	0.6872
	677	676	675	673	669	666	660	654
YEAR 3	0.8353	0.7569	0.7101	0.5473	0.4331	0.3574	0.2686	0.2719
	736	734	733	730	727	724	720	714
YEAR 4	0.8408	0.7377	0.6435	0.4344	0.3457	0.2719	0.1851	0.0997
	738	736	735	732	729	726	720	714
FISHZ	0.8977	0.8429	0.7932	0.6666	0.5823	0.5230	0.4745	0.4343
LINEAR REG	0.8523	0.8226	0.7938	0.7136	0.6414	0.5766	0.4659	0.3764

TOT NUM OBS 1HR COR 2725

SERIAL CORRELATION COEFFICIENTS AND EXPONENTIAL DECAY FUNCTIONS
YPENBURG AEROSOL INFRARED TRANSMISSION 3.4-5.0 MICRONS (%)

JANUARY

	HR 1	HR 2	HR 3	HR 6	HR 9	HR 12	HR 18	HR 24
OVERALL	0.7266	0.6283	0.5531	0.4337	0.3894	0.3545	0.2873	0.2345
YEAR 1	0.6417	0.5495	0.4982	0.3792	0.3154	0.2765	0.2189	0.1741
	642	638	634	625	619	613	605	599
YEAR 2	0.7190	0.6074	0.5164	0.4516	0.3936	0.3279	0.2339	0.1453
	702	697	697	693	690	687	681	676
YEAR 3	0.6886	0.5907	0.4944	0.3224	0.3077	0.2928	0.1837	0.1681
	728	726	723	716	713	710	704	698
YEAR 4	0.7261	0.5941	0.5109	0.2848	0.2290	0.2136	0.2220	0.1548
	698	696	696	691	687	683	677	672
FISHZ	0.6963	0.5866	0.5051	0.3605	0.3126	0.2785	0.2143	0.1603
LINEAR REG	0.6322	0.5880	0.5470	0.4402	0.3543	0.2851	0.1847	0.1196

TOT NUM OBS 1HR COR 2770

FEBRUARY

	HR 1	HR 2	HR 3	HR 6	HR 9	HR 12	HR 18	HR 24
OVERALL	0.7798	0.6927	0.5315	0.4423	0.3356	0.2655	0.1402	0.0989
YEAR 1	0.7899	0.6850	0.6039	0.4570	0.3584	0.3014	0.2008	0.0919
	623	618	615	605	599	594	583	573
YEAR 2	0.7635	0.6786	0.6268	0.3918	0.2701	0.2393	0.1033	0.1375
	573	573	566	555	544	540	531	519
YEAR 3	0.8113	0.7251	0.6651	0.4956	0.3733	0.2267	0.0392	0.0337
	671	667	663	657	652	648	642	636
YEAR 4	0.6965	0.6256	0.5704	0.3408	0.2829	0.2917	0.2963	0.2732
	606	604	602	596	590	584	572	561
FISHZ	0.7700	0.6814	0.6188	0.4257	0.3242	0.2647	0.1591	0.1317
LINEAR REG	0.7455	0.6794	0.6192	0.4688	0.3549	0.2686	0.1540	0.0882

TOT NUM OBS 1HR COR 2473

MARCH

	HR 1	HR 2	HR 3	HR 6	HR 9	HR 12	HR 18	HR 24
OVERALL	0.7281	0.6411	0.5699	0.4031	0.3332	0.2787	0.2228	0.2239
YEAR 1	0.7908	0.7638	0.7283	0.6127	0.5760	0.5353	0.4851	0.4184
	618	615	614	602	594	585	567	551
YEAR 2	0.6404	0.4609	0.3306	0.1038	0.0215	0.0209	0.0253	0.0095
	653	649	646	637	632	628	618	607
YEAR 3	0.6797	0.5376	0.4176	0.2081	0.1309	0.0471	0.0288	0.0902
	698	695	692	687	681	676	667	660
YEAR 4	0.6354	0.5368	0.4746	0.2507	0.0903	0.0065	0.0757	0.0587
	726	723	721	717	714	710	704	699
FISHZ	0.6894	0.5840	0.5004	0.3022	0.2096	0.1523	0.1508	0.1390
LINEAR REG	0.6343	0.5769	0.5247	0.3948	0.2971	0.2235	0.1265	0.0716

TOT NUM OBS 1HR COR 2695

APRIL

	HR 1	HR 2	HR 3	HR 6	HR 9	HR 12	HR 18	HR 24
OVERALL	0.6100	0.5232	0.4326	0.2198	0.1373	0.1255	0.0672	0.1489
YEAR 1	0.4399	0.3385	0.2414	0.0848	0.0588	0.1021	0.1501	0.1546
	542	538	535	523	516	512	504	494
YEAR 2	0.6265	0.5383	0.4664	0.2413	0.1060	0.0428	0.0199	0.1560
	701	699	696	692	689	686	680	674
YEAR 3	0.5656	0.4358	0.3405	0.1350	0.0656	0.0913	0.0543	0.0701
	708	705	703	700	697	694	689	682
YEAR 4	0.6683	0.6426	0.5059	0.1801	0.0743	0.0117	0.0130	0.0119
	360	377	374	368	362	356	344	332
FISHZ	0.5766	0.4846	0.3866	0.1636	0.0778	0.0664	0.0593	0.1073
LINEAR REG	0.5284	0.4749	0.4268	0.3099	0.2250	0.1633	0.0861	0.0454

TOT NUM OBS 1HR COR 2331

SERIAL CORRELATION COEFFICIENTS AND EXPONENTIAL DECAY FUNCTIONS
YPENBURG AEROSOL INFRARED TRANSMISSION 3.4-5.0 MICRONS (%)

MAY

	HR 1	HR 2	HR 3	HR 6	HR 9	HR 12	HR 18	HR 24
OVERALL	0.5904	0.4573	0.3659	0.2155	0.1383	0.1463	0.1905	0.2069
YEAR 1	0.5009	0.3617	0.2532	0.0409	0.0682	0.0036	0.1810	0.1471
	221	219	217	211	205	199	187	175
YEAR 2	0.6079	0.4086	0.3012	0.0954	0.1001	0.0410	0.0655	0.0920
	570	567	564	555	548	542	530	518
YEAR 3	0.5975	0.4777	0.3966	0.2603	0.1513	0.1818	0.1915	0.1944
	717	715	713	706	703	700	696	692
YEAR 4	0.4306	0.4064	0.2314	0.1065	0.0452	0.0670	0.0674	0.0183
	196	194	192	188	185	182	176	170
FISHZ	0.5722	0.4325	0.3291	0.1615	0.1121	0.1008	0.1350	0.1363
LINEAR REG	0.4871	0.4485	0.4131	0.3226	0.2520	0.1968	0.1200	0.0732

TOT NUM OBS 1HR COR 1704

JUNE

	HR 1	HR 2	HR 3	HR 6	HR 9	HR 12	HR 18	HR 24
OVERALL	0.4677	0.3799	0.3079	0.1733	0.1245	0.1521	0.0815	0.0784
YEAR 1	0.4655	0.3389	0.2870	0.0938	0.0915	0.1537	0.0513	0.0474
	710	707	706	703	700	697	693	687
YEAR 2	0.4628	0.4514	0.3290	0.2645	0.0962	0.0549	0.0351	0.0411
	409	406	401	390	378	367	347	323
YEAR 3	0.4639	0.3832	0.3134	0.2291	0.1877	0.2059	0.1632	0.1610
	579	560	552	536	525	519	508	506
YEAR 4	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0	0	0	0	0	0	0	0
FISHZ	0.4643	0.3819	0.3060	0.1801	0.1244	0.1484	0.0847	0.0843
LINEAR REG	0.4195	0.3800	0.3442	0.2559	0.1902	0.1414	0.0781	0.0432

TOT NUM OBS 1HR COR 1639

JULY

	HR 1	HR 2	HR 3	HR 6	HR 9	HR 12	HR 18	HR 24
OVERALL	0.5896	0.4842	0.4227	0.2829	0.1692	0.0924	0.1364	0.1918
YEAR 1	0.3381	0.2439	0.1798	0.1580	0.0711	0.0037	0.0139	0.0770
	743	742	741	738	735	732	726	720
YEAR 2	0.6463	0.5748	0.5477	0.3135	0.1694	0.0966	0.1403	0.0964
	631	627	623	610	598	586	563	545
YEAR 3	0.7196	0.6762	0.6135	0.5115	0.4050	0.3289	0.4195	0.5142
	589	575	562	530	512	508	502	508
YEAR 4	0.6405	0 4585	0.3726	0.1969	0.0820	0.0042	0.0325	0.1360
	716	714	712	706	700	694	682	670
FISHZ	0.5921	0.4890	0.4252	0.2843	0.1681	0.0933	0.1350	0.1973
LINEAR REG	0.5194	0.4871	0.4568	0.3769	0.3109	0.2565	0.1746	0.1188

TOT NUM OBS 1HR COR 2679

AUGUST

	HR 1	HR 2	HR 3	HR 6	HR 9	HR 12	HR 18	HR 24
OVERALL	0.5814	0.4858	0.4169	0.2601	0.1847	0.1447	0.1785	0.1936
YEAR 1	0.5102	0.4251	0.3815	0.2239	0.1311	0.0798	0.1796	0.1401
	605	602	599	594	587	581	570	557
YEAR 2	0.5414	0.4924	0.3211	0.1416	0.1000	0.0751	0.0780	0.1271
	507	502	498	488	475	464	453	448
YEAR 3	0.5414	0.3965	0.3186	0.0887	0.0470	0.0533	0.1123	0.3010
	443	419	398	349	321	307	319	339
YEAR 4	0.5957	0.5099	0.4082	0.2596	0.1613	0.1079	0.0847	0.0950
	737	736	735	732	729	726	720	715
FISHZ	0.5516	0.4438	0.3663	0.1965	0.1220	0.0847	0.1139	0.1490
LINEAR REG	0.4814	0.4454	0.4120	0.3262	0.2583	0.2045	0.1282	0.0804

TOT NUM OBS 1HR COR 2292

SERIAL CORRELATION COEFFICIENTS AND EXPONENTIAL DECAY FUNCTIONS
YPENBURG AEROSOL INFRARED TRANSMISSION 3.4-5.0 MICRONS (%)

SEPTEMBER

	HR 1	HR 2	HR 3	HR 6	HR 9	HR 12	HR 18	HR 24
OVERALL	0.5967	0.4904	0.3961	0.1783	0.0467	0.0597	0.0591	0.1522
YEAR 1	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0	0	0	0	0	0	0	0
YEAR 2	0.5377	0.4853	0.3834	0.1093	0.0821	0.1509	0.0625	0.1727
	656	652	648	639	630	622	610	600
YEAR 3	0.6503	0.5058	0.4348	0.2218	0.0333	0.0536	0.0213	0.0834
	637	633	627	618	606	597	579	562
YEAR 4	0.5917	0.4695	0.3571	0.1825	0.0037	0.0612	0.0700	0.1799
	694	691	688	682	677	673	667	661
FISHZ	0.5946	0.4865	0.3911	0.1713	0.0390	0.0885	0.0524	0.1480
LINEAR REG	0.5275	0.4867	0.4490	0.3526	0.2769	0.2175	0.1341	0.0827

TOT NUM OBS 1HR COR 1987

OCTOBER

	HR 1	HR 2	HR 3	HR 6	HR 9	HR 12	HR 18	HR 24
OVERALL	0.8630	0.8192	0.7669	0.7079	0.6825	0.6652	0.6533	0.6934
YEAR 1	0.7342	0.6432	0.5541	0.4337	0.3740	0.3260	0.2962	0.2902
	498	491	484	465	452	446	442	430
YEAR 2	0.7865	0.6946	0.6256	0.4715	0.3584	0.2576	0.2122	0.2350
	643	641	639	631	622	613	600	587
YEAR 3	0.7500	0.6100	0.4894	0.3264	0.2333	0.1604	0.1543	0.1773
	678	676	672	663	653	645	626	616
YEAR 4	0.5202	0.4041	0.2274	0.0599	0.0206	0.0380	0.0426	0.1766
	610	596	585	554	528	512	521	534
FISHZ	0.7113	0.5980	0.4870	0.3315	0.2504	0.1966	0.1735	0.2156
LINEAR REG	0.6269	0.5843	0.5446	0.4410	0.3571	0.2891	0.1896	0.1243

TOT NUM OBS 1HR COR 2429

NOVEMBER

	HR 1	HR 2	HR 3	HR 6	HR 9	HR 12	HR 18	HR 24
OVERALL	0.7036	0.6083	0.5392	0.3251	0.2805	0.2678	0.2589	0.3529
YEAR 1	0.6907	0.5933	0.5340	0.3712	0.3117	0.3033	0.2892	0.2471
	705	703	701	696	693	690	684	678
YEAR 2	0.7861	0.7542	0.6951	0.5480	0.4657	0.4219	0.4361	0.3960
	641	636	635	628	618	611	605	598
YEAR 3	0.6157	0.4396	0.3429	0.0263	0.0312	0.0380	0.0439	0.2686
	515	512	510	505	499	493	481	469
YEAR 4	0.6468	0.5697	0.4976	0.3242	0.2860	0.2956	0.2235	0.2985
	689	686	683	674	668	662	650	640
FISHZ	0.6935	0.6080	0.5371	0.3441	0.2929	0.2819	0.2644	0.3036
LINEAR REG	0.6116	0.5841	0.5578	0.4858	0.4230	0.3684	0.2794	0.2119

TOT NUM OBS 1HR COR 2550

DECEMBER

	HR 1	HR 2	HR 3	HR 6	HR 9	HR 12	HR 18	HR 24
OVERALL	0.6785	0.5534	0.4675	0.2704	0.1956	0.1594	0.1272	0.1193
YEAR 1	0.7572	0.6427	0.5130	0.2576	0.1212	0.0828	0.1299	0.2172
	476	473	469	462	455	448	436	422
YEAR 2	0.6659	0.5100	0.4218	0.2856	0.2356	0.2272	0.1376	0.1447
	717	715	712	709	710	708	702	697
YEAR 3	0.6126	0.4565	0.4667	0.2566	0.1842	0.1474	0.1030	0.0555
	731	730	730	726	723	720	714	708
YEAR 4	0.6395	0.5587	0.4339	0.2375	0.2047	0.1363	0.0786	0.0255
	731	728	726	722	719	717	710	704
FISHZ	0.6635	0.5356	0.4544	0.2594	0.1930	0.1554	0.1103	0.0992
LINEAR REG	0.6089	0.5435	0.4850	0.3448	0.2451	0.1742	0.0880	0.0445

TOT NUM OBS 1HR COR 2655

SERIAL CORRELATION COEFFICIENTS AND EXPONENTIAL DECAY FUNCTIONS
YPENBURG EQUIVALENT INFRARED AEROSOL EXTINCTION 3.4-5.0 MICRONS (PER KM)

JANUARY

	HR 1	HR 2	HR 3	HR 6	HR 9	HR 12	HR 18	HR 24
OVERALL	0.7201	0.6268	0.5513	0.4482	0.4119	0.3659	0.3038	0.2601
YEAR 1	0.6349	0.5382	0.4910	0.3849	0.3213	0.2854	0.2323	0.1919
	642	638	634	625	619	613	605	599
YEAR 2	0.7188	0.6128	0.5081	0.4417	0.4096	0.3258	0.2220	0.1670
	702	697	697	693	690	687	681	676
YEAR 3	0.6717	0.5703	0.4846	0.3435	0.3203	0.2851	0.2003	0.1868
	728	726	723	716	713	710	704	698
YEAR 4	0.7133	0.5926	0.5046	0.3039	0.2471	0.2259	0.2566	0.1578
	698	696	696	691	687	683	677	672
FISHZ	0.6870	0.5799	0.4971	0.3691	0.3260	0.2809	0.2275	0.1756
LINEAR REG	0.6206	0.5804	0.5429	0.4442	0.3635	0.2974	0.1991	0.1333

TOT NUM OBS 1HR COR 2770

FEBRUARY

	HR 1	HR 2	HR 3	HR 6	HR 9	HR 12	HR 18	HR 24
OVERALL	0.7716	0.6811	0.6160	0.4307	0.3240	0.2528	0.1452	0.1304
YEAR 1	0.7967	0.6987	0.6268	0.4541	0.3624	0.3143	0.2203	0.1268
	623	618	615	605	599	594	583	573
YEAR 2	0.7654	0.6732	0.6158	0.4047	0 2704	0.2201	0.1112	0.1681
	573	573	566	555	544	540	531	519
YEAR 3	0.7807	0.6822	0.6137	0.4474	0.3312	0.1792	0.0077	0.0026
	671	667	663	657	652	648	642	636
YEAR 4	0.7032	0.6344	0.5679	0.3471	0.2745	0.2832	0.2851	0.2560
	606	604	602	596	590	584	572	561
FISHZ	0.7643	0.6732	0.6067	0.4154	0.3117	0.2489	0.1545	0.1345
LINEAR REG	0.7362	0.6702	0.6100	0.4600	0.3469	0.2617	0.1488	0.0846

TOT NUM OBS 1HR COR 2473

MARCH

	HR 1	HR 2	HR 3	HR 6	HR 9	HR 12	HR 18	HR 24
OVERALL	0.7383	0.6425	0.5732	0.4051	0.3354	0.2811	0.2356	0.2429
YEAR 1	0.8158	0.7780	0.7413	0.6132	0.6041	0.5595	0.5017	0.4346
	618	615	614	602	594	585	567	551
YEAR 2	0.6306	0.4524	0.3310	0.1043	0.0219	0.0112	0.0096	0.0281
	653	649	646	637	632	628	618	607
YEAR 3	0.6964	0.5598	0.4533	0.2283	0.1477	0.0656	0.0019	0.0952
	698	695	692	687	681	676	667	660
YEAR 4	0.6326	0.5060	0.4400	0.2601	0.0445	0.0394	0.0842	0.0119
	726	723	721	717	714	710	704	699
FISHZ	0.6993	0.5854	0.5050	0.3099	0.2113	0.1711	0.1473	0.1361
LINEAR REG	0.6425	0.5834	0.5297	0.3965	0.2968	0.2222	0.1245	0.0698

TOT NUM OBS 1HR COR 2695

APRIL

	HR 1	HR 2	HR 3	HR 6	HR 9	HR 12	HR 18	HR 24
OVERALL	0.5780	0.5032	0.4218	0.2275	0.1492	0.1280	0.6791	0.1446
YEAR 1	0.4197	0.3310	0.2473	0.0943	0.0736	0.0963	0.1596	0.1454
	542	538	535	523	516	512	504	494
YEAR 2	0.5804	0.4981	0.4384	0.2420	0.1099	0.0381	0.0205	0.1546
	701	699	696	692	689	686	680	674
YEAR 3	0.5343	0.4292	0.3374	0.1445	0.0781	0.0894	0.0347	0.0533
	708	705	703	700	697	694	689	682
YEAR 4	0.6311	0.6154	0.4890	0.1812	0.0766	0.0209	0.0170	0.0138
	380	377	374	368	362	356	344	332
FISHZ	0.5411	0.4627	0.3747	0.1690	0.0864	0.0632	0.0562	0.0998
LINEAR REG	0.5014	0.4498	0.4035	0.2913	0.2103	0.1518	0.0791	0.0412

TOT NUM OBS 1HR COR 2331

SERIAL CORRELATION COEFFICIENTS AND EXPONENTIAL DECAY FUNCTIONS
YPENBURG EQUIVALENT INFRARED AEROSOL EXTINCTION 3.4-5.0 MICRONS (PER KM)

MAY

	HR 1	HR 2	HR 3	HR 6	HR 9	HR 12	HR 18	HR 24
OVERALL	0.6050	0.4792	0.4836	0.2347	0.1902	0.1923	0.1870	0.1944
YEAR 1	0.6002	0.4619	0.3577	0.0867	0.0466	0.0989	0.1386	0.1517
	221	219	217	211	[illegible]	199	187	175
YEAR 2	0.6226	0.4555	0.3137	0.1114	0.1380	0.0710	0.0571	0.0832
	570	567	564	555	548	542	530	518
YEAR 3	0.5630	0.4379	0.3641	0.2544	0.1898	0.2007	0.1853	0.1684
	717	715	713	706	703	700	696	692
YEAR 4	0.4407	0.4128	0.2464	0.1141	0.0565	0.0896	0.0400	0.0417
	196	194	192	188	185	182	176	170
FISHZ	0.5761	0.4441	0.3336	0.1706	0.1402	0.1331	0.1216	0.1247
LINEAR REG	0.4967	6.4535	0.4141	0.3153	0.2400	0.1827	0.1059	0.0614

TOT NUM OBS 1HR COR 1704

JUNE

	HR 1	HR 2	HR 3	HR 6	HR 9	HR 12	HR 18	HR 24
OVERALL	0.4414	0.3574	0.2843	0.1553	0.1199	0.1526	0.0769	0.0614
YEAR 1	0.4453	0.3199	0.2750	0.0907	0.0924	0.1626	0.0447	0.0446
	710	707	706	703	700	697	693	687
YEAR 2	6.4260	0.4179	0.2674	0.2279	0.0887	0.0674	0.0254	0.0043
	409	406	401	390	378	367	347	323
YEAR 3	0.4350	0.3618	0.2976	0.1951	0.1709	0.1785	0.1586	0.1233
	570	560	552	536	525	519	508	506
YEAR 4	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0	0	0	0	0	0	0	0
FISHZ	0.4372	0.3583	0.2807	0.1584	0.1174	0.1461	0.0781	0.0624
LINEAR REG	0.3974	0.3574	0.3214	0.2337	0.1700	0.1236	0.0654	0.0346

TOT NUM OBS 1HR COR 1689

JULY

	HR 1	HR 2	HR 3	HR 6	HR 9	HR 12	HR 18	HR 24
OVERALL	0.5957	0.4884	0.4290	0.2989	0.1998	0.1283	0.1436	0.1829
YEAR 1	0.3721	0.2497	0.1920	0.1789	0.0820	6.0186	0.0093	0.0876
	743	742	741	738	735	732	726	720
YEAR 2	0.6197	0.5568	0.5307	0.3232	0.2044	0.1482	0.1293	0.0378
	631	627	623	610	598	586	563	545
YEAR 3	0.7133	0.6699	0.6225	0.5525	0.4785	0.4185	0.4641	0.4995
	589	575	562	530	512	508	502	508
YEAR 4	0.6377	0.4615	0.3675	0.1851	0.0875	0.0124	0.0351	0.1360
	716	714	712	706	700	694	682	670
FISHZ	0.5896	0.4841	0.4247	0.2999	0.1986	0.1325	0.1429	0.1838
LINEAR REG	0.5203	0.4859	0.4538	0.3696	0.3011	0.2452	0.1627	0.1079

TOT NUM OBS 1HR COR 2679

AUGUST

	HR 1	HR 2	HR 3	HR 6	HR 9	HR 12	HR 18	HR 24
OVERALL	0.5735	0.4897	0.4085	0.3068	0.2137	0.1894	0.1895	0.2041
YEAR 1	0.4926	0.4467	0.3709	6.2453	0.1344	6.1269	0.1674	0.1643
	605	602	599	594	587	581	570	557
YEAR 2	0.5085	0.3940	0.3083	0.1639	0.1325	0.0908	0.0981	0.1776
	507	502	498	488	475	464	453	448
YEAR 3	0.5551	0.3929	0.3260	0.1736	0.1602	0.1722	0.1469	0.2932
	443	419	398	349	321	307	319	339
YEAR 4	0.5864	0.4966	0.3891	0.2696	0.1809	0.1421	0.0836	0.0937
	737	736	735	732	729	726	720	715
FISHZ	0.5395	0.4424	0.3554	0.2241	0.1546	0.1292	0.1255	0.1664
LINEAR REG	0.4676	0.4361	0.4067	0.3299	0.2676	0.2171	0.1429	0.0940

TOT NUM OBS 1HR COR 2292

SERIAL CORRELATION COEFFICIENTS AND EXPONENTIAL DECAY FUNCTIONS
YPENBURG EQUIVALENT INFRARED AEROSOL EXTINCTION 3.4-5.0 MICRONS (PER KM)

SEPTEMBER

	HR 1	HR 2	HR 3	HR 6	HR 9	HR 12	HR 18	HR 24
OVERALL	0.5773	0.4815	0.3981	0.1831	0.0610	0.0655	0.0821	0.1464
YEAR 1	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0	0	0	0	0	0	0	0
YEAR 2	0.5149	0.4922	0.3878	0.1143	0.1047	0.1739	0.1149	0.1675
	656	652	648	639	630	622	610	600
YEAR 3	0.6386	0.4994	0.4341	0.2161	0.0386	0.0519	0.0172	0.0723
	637	633	627	618	606	597	579	562
YEAR 4	0.5632	0.4410	0.3559	0.1933	0.0199	0.0648	0.0985	0.1826
	694	691	688	682	677	673	667	661
FISHZ	0.5734	0.4770	0.3919	0.1748	0.0538	0.0969	0.0787	0.1440
LINEAR REG	0.5135	0.4729	0.4354	0.3400	0.2655	0.2074	0.1264	0.0771

TOT NUM OBS 1HR COR 1987

OCTOBER

	HR 1	HR 2	HR 3	HR 6	HR 9	HR 12	HR 18	HR 24
OVERALL	0.8274	0.7521	0.6915	0.6310	0.5591	0.5284	0.5043	0.5388
YEAR 1	0.7415	0.6524	0.5604	0.4552	0.3848	0.3286	0.2964	0.2981
	498	491	484	465	452	446	442	430
YEAR 2	0.7622	0.6778	0.6068	0.4264	0.2851	0.1819	0.1602	0.2587
	643	641	639	631	622	613	600	587
YEAR 3	0.7316	0.5777	0.4712	0.3033	0.2363	0.1824	0.1714	0.2220
	678	676	672	663	653	645	626	616
YEAR 4	0.5368	0.3480	0.2039	0.0339	0.0397	0.0553	0.0046	0.0374
	611	597	586	555	529	513	522	535
FISHZ	0.7021	0.5746	0.4722	0.3102	0.2366	0.1838	0.1552	0.2031
LINEAR REG	0.6142	0.5705	0.5300	0.4248	0.3405	0.2729	0.1753	0.1126

TOT NUM OBS 1HR COR 2430

NOVEMBER

	HR 1	HR 2	HR 3	HR 6	HR 9	HR 12	HR 18	HR 24
OVERALL	0.6890	0.6036	0.5448	0.3514	0.3176	0.3108	0.3828	0.3448
YEAR 1	0.6867	0.5955	0.5362	0.3750	0.3133	0.3227	0.3047	0.2459
	705	703	701	696	693	690	684	678
YEAR 2	0.7080	0.7001	0.6540	0.4985	0.4597	0.4103	0.3987	0.3666
	641	636	635	628	618	611	605	598
YEAR 3	0.6110	0.4314	0.3567	0.0213	0.0219	0.0346	0.0220	0.2632
	515	512	510	505	499	493	481	469
YEAR 4	0.6574	0.5810	0.5134	0.3438	0.3065	0.3027	0.2523	0.2934
	689	686	683	674	668	662	650	640
FISHZ	0.6702	0.5918	0.5305	0.3345	0.2953	0.2856	0.2619	0.2930
LINEAR REG	0.5956	0.5689	0.5434	0.4736	0.4127	0.3596	0.2731	0.2074

TOT NUM OBS 1HR COR 2550

DECEMBER

	HR 1	HR 2	HR 3	HR 6	HR 9	HR 12	HR 18	HR 24
OVERALL	0.6586	0.5340	0.4422	0.2587	0.1972	0.1724	0.1271	0.1240
YEAR 1	0.7294	0.6234	0.4884	0.2327	0.1162	0.1035	0.0979	0.1801
	476	473	469	462	455	448	436	422
YEAR 2	0.6529	0.4955	0.4072	0.2727	0.2331	0.2370	0.1499	0.1438
	717	715	712	709	710	708	702	697
YEAR 3	0.5781	0.4131	0.4249	0.2364	0.1899	0.1710	0.1034	0.0833
	731	730	730	726	723	720	714	708
YEAR 4	0.6179	0.5362	0.3984	0.2280	0.1869	0.1065	0.0804	0.0032
	731	728	726	722	719	717	710	704
FISHZ	0.6394	0.5104	0.4247	0.2433	0.1883	0.1601	0.1089	0.0947
LINEAR REG	0.5816	0.5197	0.4644	0.3313	0.2364	0.1687	0.0859	0.0437

TOT NUM OBS 1HR COR 2655

SERIAL CORRELATION COEFFICIENTS AND EXPONENTIAL DECAY FUNCTIONS
YPENBURG AEROSOL INFRARED TRANSMISSION 8.0-12.0 MICRONS (%)

JANUARY

	HR 1	HR 2	HR 3	HR 6	HR 9	HR 12	HR 18	HR 24
OVERALL	0.6826	0.5612	0.4778	0.3242	0.2763	0.2583	0.2265	0.1858
YEAR 1	0.5791	0.4785	0.3894	0.3006	0.1837	0.2240	0.2388	0.1623
	641	638	634	625	619	613	605	599
YEAR 2	0.6795	0.5597	0.4788	0.3854	0.3393	0.2545	0.2021	0.1263
	711	708	709	704	701	699	693	688
YEAR 3	0.6453	0.5031	0.3780	0.1495	0.1288	0.1300	0.0072	0.1204
	734	731	728	724	721	718	712	706
YEAR 4	0.6769	0.5204	0.4442	0.1593	0.1227	0.1518	0.2932	0.1050
	710	708	706	703	700	697	691	686
FISHZ	0.6485	0.5168	0.4241	0.2493	0.1953	0.1891	0.1603	0.1274
LINEAR REC	0.5735	0.5242	0.4791	0.3657	0.2792	0.2131	0.1242	0.0724

TOT NUM OBS 1HR COR 2796

FEBRUARY

	HR 1	HR 2	HR 3	HR 6	HR 9	HR 12	HR 18	HR 24
OVERALL	0.7463	0.6519	0.5658	0.3499	0.2327	0.1779	0.1188	0.1029
YEAR 1	0.6800	0.5809	0.4633	0.2508	0.1497	0.1357	0.1637	0.0864
	627	622	620	611	605	600	589	579
YEAR 2	0.7776	0.7059	0.6236	0.3739	0.1736	0.0785	0.0773	0.1492
	605	603	599	593	583	578	564	552
YEAR 3	0.7680	0.6622	0.5719	0.3705	0.2847	0.1620	0.0035	0.1090
	675	671	668	661	656	654	648	642
YEAR 4	0.6846	0.5559	0.4916	0.2766	0.2513	0.2109	0.2068	0.2208
	604	602	600	594	588	582	570	559
FISHZ	0.7[illegible]5	0.6307	0.5410	0.3205	0.2150	0.1476	0.1104	0.1401
LINEAR REC	0.68[illegible]	0.6183	0.5573	0.4080	0.2987	0.2187	0.1172	0.0628

TOT NUM OBS 1HR COR 2511

MARCH

	HR 1	HR 2	HR 3	HR 6	HR 9	HR 12	HR 18	HR 24
OVERALL	0.7033	0.6338	0.5456	0.4187	0.3171	0.3861	0.2602	0.3290
YEAR 1	0.6928	0.6495	0.5585	0.4424	0.4316	0.4063	0.3113	0.3154
	597	594	592	584	574	565	549	533
YEAR 2	0.5542	0.3857	0.2181	0.0205	0.0710	0.0324	0.0545	0.0114
	653	649	646	637	632	628	618	607
YEAR 3	0.6846	0.5490	0.4313	0.2092	0.1060	0.0627	0.0389	0.1735
	700	697	694	689	683	678	669	662
YEAR 4	0.5767	0.5069	0.4019	0.2561	0.0512	0.0153	0.0335	0.0799
	728	725	723	721	718	715	709	704
FISHZ	0.6293	0.5263	0.4063	0.2334	0.1595	0.1221	0.1019	0.1400
LINEAR REC	0.5634	0.5126	0.4664	0.3514	0.2647	0.1994	0.1131	0.0642

TOT NUM OBS 1HR COR 2678

APRIL

	HR 1	HR 2	HR 3	HR 6	HR 9	HR 12	HR 18	HR 24
OVERALL	0.6566	0.6595	0.5788	0.3955	0.2198	0.2225	0.2182	0.3581
YEAR 1	0.5505	0.4584	0.3560	0.1996	0.1565	0.1308	0.1973	0.2402
	540	536	533	521	514	510	502	492
YEAR 2	0.6608	0.5279	0.4678	0.2313	0.0826	0.0969	0.0481	0.1380
	707	704	701	698	695	692	686	680
YEAR 3	0.5454	0.4106	0.2846	0.1038	0.0238	0.0526	0.0348	0.0290
	708	707	705	702	699	696	691	684
YEAR 4	0.7686	0.7189	0.6612	0.4843	0.4423	0.4373	0.5089	0.5058
	371	367	364	359	352	346	334	322
FISHZ	0.6252	0.5154	0.4265	0.2293	0.1415	0.1472	0.1543	0.1876
LINEAR REC	0.5465	0.5092	0.4745	0.3839	0.3105	0.2512	0.16[illegible]4	0.1076

TOT NUM OBS 1HR COR 2326

SERIAL CORRELATION COEFFICIENTS AND EXPONENTIAL DECAY FUNCTIONS
YPENBURG AEROSOL INFRARED TRANSMISSION 8.0-12.0 MICRONS (%)

MAY

	HR 1	HR 2	HR 3	HR 6	HR 9	HR 12	HR 18	HR 24
OVERALL	0.5524	0.4344	0.3543	0.1542	0.0723	0.0720	0.1404	0.1831
YEAR 1	0.5260	0.4125	0.3254	0.1106	0.0734	0.1233	0.2171	0.1887
	219	217	215	209	203	197	185	174
YEAR 2	0.5160	0.3223	0.2441	0.0070	0.0609	0.0545	0.0135	0.2025
	574	571	568	560	554	548	536	524
YEAR 3	0.5298	0.4419	0.3491	0.1228	0.0089	0.0474	0.0737	0.1157
	722	720	718	712	709	706	702	696
YEAR 4	0.5079	0.4354	0.3174	0.1314	0.0513	0.0547	0.0287	0.1751
	196	194	192	188	185	182	176	170
FISHZ	0.5222	0.3986	0.3079	0.0835	0.0390	0.0597	0.0654	0.1595
LINEAR REG	0.4473	0.4201	0.3946	0.3269	0.2768	0.2244	0.1540	0.1057

TOT NUM OBS 1HR COR 1711

JUNE

	HR 1	HR 2	HR 3	HR 6	HR 9	HR 12	HR 18	HR 24
OVERALL	0.4737	0.4346	0.3653	0.2973	0.1377	0.1242	0.0762	0.1783
YEAR 1	0.4258	0.3784	0.3272	0.0942	0.0604	0.0857	0.0319	0.1066
	708	705	704	701	698	695	691	685
YEAR 2	0.5172	0.4769	0.3668	0.1805	0.0161	0.0359	0.0313	0.0614
	411	408	403	391	379	368	348	324
YEAR 3	0.3960	0.3430	0.2447	0.1690	0.1024	0.0318	0.1056	0.1744
	579	560	552	536	525	519	508	506
YEAR 4	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0	0	0	0	0	0	0	0
FISHZ	0.4392	0.3919	0.3101	0.1397	0.0638	0.0565	0.0560	0.1199
LINEAR REG	0.4018	0.3718	0.3440	0.2725	0.2159	0.1718	0.1078	0.0674

TOT NUM OBS 1HR COR 1689

JULY

	HR 1	HR 2	HR 3	HR 6	HR 9	HR 12	HR 18	HR 24
OVERALL	0.5808	0.4944	0.4073	0.2219	0.0972	0.0210	0.1211	0.2170
YEAR 1	0.3971	0.2987	0.1993	0.0505	0.0452	0.1038	0.0513	0.0587
	743	742	741	738	735	732	726	720
YEAR 2	0.5646	0.4984	0.4191	0.1939	0.0383	0.0862	0.0363	0.1123
	631	627	623	610	598	586	563	545
YEAR 3	0.6667	0.5866	0.5066	0.2668	0.1564	0.0706	0.2365	0.3006
	589	575	562	530	512	508	502	508
YEAR 4	0.6406	0.5299	0.4278	0.2126	0.0407	0.0352	0.0915	0.2290
	716	714	712	705	700	694	682	670
FISHZ	0.5696	0.4769	0.3838	0.1740	0.0649	0.0742	0.0972	0.1692
LINEAR REG	0.5036	0.4697	0.4381	0.3554	0.2884	0.2340	0.1549	0.1014

TOT NUM OBS 1HR COR 2679

AUGUST

	HR 1	HR 2	HR 3	HR 6	HR 9	HR 12	HR 18	HR 24
OVERALL	0.5694	0.4396	0.3736	0.2175	0.0964	0.0945	0.1227	0.2058
YEAR 1	0.5571	0.4536	0.3692	0.2530	0.1112	0.0964	0.1378	0.1895
	608	606	603	598	591	585	573	561
YEAR 2	0.5354	0.3441	0.2919	0.1204	0.0372	0.0410	0.0356	0.1941
	511	506	502	491	479	468	457	452
YEAR 3	0.5021	0.3780	0.3210	0.0176	0.0360	0.0157	0.0961	0.3554
	443	419	398	349	321	307	319	339
YEAR 4	0.6144	0.4679	0.4129	0.2479	0.1384	0.1361	0.1216	0.1518
	741	740	739	736	733	730	724	718
FISHZ	0.5616	0.4213	0.3587	0.1850	0.0928	0.0863	0.1033	0.2057
LINEAR REG	0.4687	0.4435	0.4197	0.3556	0.3013	0.2553	0.1833	0.1316

TOT NUM OBS 1HR COR 2303

SERIAL CORRELATION COEFFICIENTS AND EXPONENTIAL DECAY FUNCTIONS
YPENBURG AEROSOL INFRARED TRANSMISSION 8.0-12.0 MICRONS (%)

SEPTEMBER

	HR 1	HR 2	HR 3	HR 6	HR 9	HR 12	HR 18	HR 24
OVERALL	0.6068	0.5121	0.4129	0.1554	0.0065	-0.0259	0.0691	0.2563
YEAR 1	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0	0	0	0	0	0	0	0
YEAR 2	0.6249	0.5379	0.4337	0.0927	0.0441	0.0771	0.0015	0.2830
	653	649	645	636	627	619	606	596
YEAR 3	0.5761	0.4950	0.4205	0.1565	0.0311	0.1074	0.0131	0.1706
	637	633	627	618	606	597	579	562
YEAR 4	0.5949	0.4766	0.3575	0.1601	0.0206	0.0166	0.1080	0.2609
	694	691	688	682	677	672	666	660
FISHZ	0.5988	0.5031	0.4033	0.1369	0.0316	0.0652	0.0436	0.2408
LINEAR REG	0.5242	0.5017	0.4801	0.4207	0.3687	0.3231	0.2481	0.1906

TOT NUM OBS 1HR COR 1984

OCTOBER

	HR 1	HR 2	HR 3	HR 6	HR 9	HR 12	HR 18	HR 24
OVERALL	0.7304	0.6310	0.5439	0.3704	0.3066	0.2730	0.2504	0.3235
YEAR 1	0.7049	0.5647	0.4634	0.2531	0.1939	0.2194	0.1867	0.3049
	504	497	491	473	460	453	448	438
YEAR 2	0.7894	0.7092	0.6161	0.4591	0.3400	0.2537	0.2561	0.3118
	651	650	649	636	626	620	610	596
YEAR 3	0.6546	0.5362	0.4541	0.2316	0.2153	0.1440	0.1122	0.2205
	681	679	677	666	657	649	630	620
YEAR 4	0.6875	0.6106	0.5328	0.4281	0.3683	0.3680	0.3226	0.3034
	611	597	586	555	529	513	522	535
FISHZ	0.7133	0.6116	0.5223	0.3490	0.2827	0.2414	0.2181	0.2829
LINEAR REG	0.6242	0.5918	0.5610	0.4781	0.4074	0.3471	0.2521	0.1830

TOT NUM OBS 1HR COR 2447

NOVEMBER

	HR 1	HR 2	HR 3	HR 6	HR 9	HR 12	HR 18	HR 24
OVERALL	0.7148	0.6296	0.5470	0.3609	0.3346	0.3225	0.3007	0.4183
YEAR 1	0.6292	0.5267	0.4559	0.2397	0.1872	0.1454	0.1911	0.1636
	710	708	706	701	698	695	689	683
YEAR 2	0.7864	0.7117	0.6731	0.5333	0.4929	0.4839	0.4383	0.3734
	661	657	654	647	641	639	629	624
YEAR 3	0.6746	0.5601	0.4435	0.2010	0.1790	0.1581	0.1599	0.4193
	523	520	518	513	507	502	489	477
YEAR 4	0.5866	0.5299	0.4327	0.2561	0.2432	0.2600	0.1427	0.2304
	689	686	683	674	668	662	650	640
FISHZ	0.6753	0.5878	0.5110	0.3188	0.2846	0.2714	0.2402	0.2888
LINEAR REG	0.5927	0.5650	0.5306	0.4667	0.4043	0.3503	0.2630	0.1974

TOT NUM OBS 1HR COR 2583

DECEMBER

	HR 1	HR 2	HR 3	HR 6	HR 9	HR 12	HR 18	HR 24
OVERALL	0.6988	0.5592	0.4708	0.2868	0.2086	0.1599	0.1556	0.1343
YEAR 1	0.7781	0.6299	0.5053	0.2674	0.1362	0.0982	0.2253	0.2225
	492	490	486	481	475	468	456	444
YEAR 2	0.6664	0.4934	0.4066	0.2538	0.1501	0.0939	0.0625	0.0477
	716	714	712	708	709	708	701	697
YEAR 3	0.6616	0.5479	0.5226	0.3671	0.3353	0.2416	0.1899	0.1842
	735	734	733	730	727	724	718	712
YEAR 4	0.6781	0.5495	0.4224	0.2124	0.1578	0.1596	0.0898	0.0225
	738	736	735	732	729	726	720	714
FISHZ	0.6916	0.5505	0.4624	0.2772	0.2025	0.1540	0.1345	0.1095
LINEAR REG	0.6257	0.5618	0.5044	0.3631	0.2643	0.1913	0.1002	0.0525

TOT NUM OBS 1HR COR 2681

SERIAL CORRELATION COEFFICIENTS AND EXPONENTIAL DECAY FUNCTIONS
YPENBURG EQUIVALENT INFRARED AEROSOL EXTINCTION 8.0-12.0 MICRONS (PER KM)

JANUARY

	HR 1	HR 2	HR 3	HR 6	HR 9	HR 12	HR 18	HR 24
OVERALL	0.6750	0.5555	0.4660	0.3142	0.2831	0.2543	0.2187	0.1913
YEAR 1	0.5920	0.4765	0.3811	0.2855	0.1988	0.2296	0.2361	0.1721
	641	638	634	625	619	613	605	599
YEAR 2	0.6655	0.5459	0.4514	0.3660	0.3358	0.2285	0.1638	0.0968
	711	708	709	704	701	699	693	688
YEAR 3	0.6263	0.4966	0.3895	0.1682	0.1522	0.1387	0.0109	0.1573
	734	731	728	724	721	718	712	706
YEAR 4	0.6789	0.5255	0.4336	0.1461	0.1258	0.1496	0.2672	0.1120
	710	709	706	703	700	697	691	686
FISHZ	0.6430	0.5123	0.4150	0.2419	0.2054	0.1853	0.1518	0.1336
LINEAR REG	0.5666	0.5184	0.4743	0.3632	0.2781	0.2130	0.1249	0.0732

TOT NUM OBS 1HR COR 2796

FEBRUARY

	HR 1	HR 2	HR 3	HR 6	HR 9	HR 12	HR 18	HR 24
OVERALL	0.7245	0.6259	0.5434	0.3397	0.2545	0.1766	0.1433	0.1209
YEAR 1	0.6748	0.5857	0.4729	0.2546	0.1651	0.1327	0.1580	0.0845
	627	622	620	611	605	600	589	579
YEAR 2	0.7658	0.6965	0.6257	0.4042	0.2347	0.1374	0.1312	0.1609
	605	603	599	593	593	578	564	552
YEAR 3	0.7130	0.5871	0.4888	0.2822	0.2287	0.1080	0.0263	0.0783
	675	671	668	661	658	654	648	642
YEAR 4	0.6928	0.5675	0.5084	0.3168	0.3078	0.2347	0.2524	0.2427
	604	602	600	594	588	582	570	559
FISHZ	0.7136	0.6112	0.5254	0.3143	0.2340	0.1571	0.1392	0.1395
LINEAR REG	0.6639	0.6017	0.5453	0.4059	0.3022	0.2256	0.1247	0.0691

TOT NUM OBS 1HR COR 2511

MARCH

	HR 1	HR 2	HR 3	HR 6	HR 9	HR 12	HR 18	HR 24
OVERALL	0.6945	0.6102	0.5111	0.3726	0.2974	0.2764	0.2153	0.2678
YEAR 1	0.6851	0.6167	0.5286	0.3953	0.3959	0.3850	0.2812	0.2866
	597	594	592	584	574	565	549	533
YEAR 2	0.5394	0.3690	0.2179	0.0317	0.0637	0.0063	0.0357	0.0215
	653	649	646	637	632	628	618	607
YEAR 3	0.6755	0.5325	0.4208	0.2120	0.1631	0.1336	0.0458	0.1089
	700	697	694	689	683	678	669	662
YEAR 4	0.5982	0.5302	0.3980	0.2423	0.0700	0.0047	0.0779	0.0413
	728	725	723	721	718	715	709	704
FISHZ	0.6269	0.5158	0.3944	0.2209	0.1684	0.1260	0.1044	0.1079
LINEAR REG	0.5668	0.5079	0.4551	0.3274	0.2355	0.1695	0.0877	0.0454

TOT NUM OBS 1HR COR 2678

APRIL

	HR 1	HR 2	HR 3	HR 6	HR 9	HR 12	HR 18	HR 24
OVERALL	0.6661	0.5516	0.5804	0.3152	0.2402	0.2474	0.2171	0.2682
YEAR 1	0.5805	0.4606	0.3668	0.2254	0.1477	0.1607	0.1956	0.2873
	540	536	533	521	514	510	502	492
YEAR 2	0.6576	0.5118	0.4566	0.2323	0.1005	0.1104	0.0526	0.1626
	707	704	701	698	695	692	686	680
YEAR 3	0.5493	0.4141	0.3037	0.1651	0.0902	0.1072	0.0135	0.0480
	708	707	705	702	699	696	691	684
YEAR 4	0.7942	0.7451	0.7056	0.5476	0.5245	0.5204	0.5519	0.5513
	371	367	364	359	352	346	334	322
FISHZ	0.6376	0.5185	0.4412	0.2662	0.1813	0.1907	0.1576	0.2208
LINEAR REG	0.5495	0.5164	0.4354	0.4030	0.3346	0.2778	0.1915	0.1320

TOT NUM OBS 1HR COR 2326

SERIAL CORRELATION COEFFICIENTS AND EXPONENTIAL DECAY FUNCTIONS
YPENBURG EQUIVALENT INFRARED AEROSOL EXTINCTION 8.0-12.0 MICRONS (PER KM)

MAY

	HR 1	HR 2	HR 3	HR 6	HR 9	HR 12	HR 18	HR 24
OVERALL	0.5523	0.4300	0.3557	0.1630	0.0653	0.0428	0.1440	0.1821
YEAR 1	0.5881	0.4875	0.3763	0.1504	0.0302	0.1507	0.2250	0.1814
	219	217	215	209	203	197	185	174
YEAR 2	0.5308	0.3526	0.2726	0.0486	0.0355	0.0659	0.0589	0.1965
	574	571	568	560	554	548	536	524
YEAR 3	0.4965	0.3775	0.3312	0.1319	0.0317	0.0481	0.0726	0.0739
	722	720	718	712	709	706	702	696
YEAR 4	0.4595	0.4152	0.2701	0.1417	0.0363	0.0119	0.0907	0.0190
	196	194	192	188	185	182	176	170
FISHZ	0.5164	0.3862	0.3108	0.1074	0.0193	0.0625	0.0878	0.1215
LINEAR REG	0.4467	0.4118	0.3797	0.2976	0.2333	0.1828	0.1123	0.0690

TOT NUM OBS 1HR COR 1711

JUNE

	HR 1	HR 2	HR 3	HR 6	HR 9	HR 12	HR 18	HR 24
OVERALL	0.5103	0.4394	0.3679	0.1832	0.1138	0.1225	0.0814	0.2007
YEAR 1	0.4660	0.3911	0.3215	0.0539	0.0048	0.0512	0.0280	0.1533
	708	705	704	701	698	695	691	685
YEAR 2	0.5013	0.4642	0.3513	0.1826	0.0285	0.0153	0.0603	0.0512
	411	408	403	391	379	368	348	324
YEAR 3	0.4517	0.3359	0.2675	0.1611	0.0872	0.0679	0.1016	0.1470
	570	560	552	536	525	519	508	506
YEAR 4	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0	0	0	0	0	0	0	0
FISHZ	0.4700	0.3915	0.3111	0.1204	0.0374	0.0484	0.0595	0.1296
LINEAR REG	0.4176	0.3885	0.3614	0.2909	0.2342	0.1885	0.1222	0.0792

TOT NUM OBS 1HR COR 1689

JULY

	HR 1	HR 2	HR 3	HR 6	HR 9	HR 12	HR 18	HR 24
OVERALL	0.6079	0.5012	0.4241	0.2463	0.1290	0.0494	0.1275	0.2190
YEAR 1	0.4478	0.3080	0.2419	0.0803	0.0400	0.0935	0.0395	0.0892
	743	742	741	738	735	732	726	720
YEAR 2	0.5598	0.4825	0.4302	0.2215	0.0749	0.0412	0.0311	0.0677
	631	627	623	610	598	586	563	545
YEAR 3	0.6697	0.5866	0.4917	0.3081	0.2652	0.1784	0.2274	0.2639
	589	575	562	530	512	508	502	508
YEAR 4	0.6672	0.5294	0.4137	0.1983	0.0382	0.0549	0.0867	0.2392
	716	714	712	706	700	694	682	670
FISHZ	0.5890	0.4752	0.3896	0.1938	0.0940	0.0881	0.0894	0.1631
LINEAR REG	0.5147	0.4769	0.4419	0.3516	0.2798	0.2226	0.1409	0.0892

TOT NUM OBS 1HR COR 2679

AUGUST

	HR 1	HR 2	HR 3	HR 6	HR 9	HR 12	HR 18	HR 24
OVERALL	0.5777	0.4453	0.3719	0.2120	0.0969	0.0939	0.1329	0.2316
YEAR 1	0.5787	0.4689	0.4081	0.2578	0.1125	0.0962	0.1758	0.2266
	608	606	603	598	591	585	573	561
YEAR 2	0.5053	0.3192	0.2711	0.1205	0.0217	0.0180	0.0692	0.1819
	511	506	502	491	479	468	457	452
YEAR 3	0.5001	0.3941	0.2936	0.0546	0.0293	0.0621	0.1018	0.3751
	443	419	398	349	321	307	319	339
YEAR 4	0.6326	0.4795	0.3859	0.2268	0.1260	0.1239	0.0994	0.1838
	741	740	739	736	733	730	724	718
FISHZ	0.5673	0.4273	0.3511	0.1847	0.0844	0.0835	0.1145	0.2276
LINEAR REG	0.4697	0.4474	0.4261	0.3682	0.3182	0.2749	0.2052	0.1532

TOT NUM OBS 1HR COR 2303

SERIAL CORRELATION COEFFICIENTS AND EXPONENTIAL DECAY FUNCTIONS
YPENBURG EQUIVALENT INFRARED AEROSOL EXTINCTION 8.0-12.0 MICRONS (PER KM)

SEPTEMBER

	HR 1	HR 2	HR 3	HR 6	HR 9	HR 12	HR 18	HR 24
OVERALL	0.5781	0.4754	0.4870	0.2730	0.0395	0.0217	0.0847	0.2189
YEAR 1	0.5781	0.4754	0.3870	0.1730	0.0395	0.0217	0.0847	0.2189
	1984	1973	1960	1936	1910	1888	1851	1818
YEAR 2	0.5770	0.4921	0.3971	0.1176	0.0252	0.0296	0.0141	0.1821
	653	649	645	636	627	619	606	596
YEAR 3	0.5581	0.4606	0.3893	0.1472	0.0239	0.0792	0.0155	0.1741
	637	633	627	618	606	597	579	562
YEAR 4	0.5605	0.4256	0.3213	0.1750	0.0201	0.0064	0.1180	0.2214
	694	691	688	682	677	672	666	660
FISHZ	0.5717	0.4673	0.3778	0.1602	0.0313	0.0294	0.0584	0.2065
LINEAR REG	0.4968	0.4720	0.4485	0.3847	0.3300	0.2831	0.2084	0.1533

TOT NUM OBS 1HR COR 3968

OCTOBER

	HR 1	HR 2	HR 3	HR 6	HR 9	HR 12	HR 18	HR 24
OVERALL	0.7071	0.6125	0.5234	0.3554	0.3945	0.2770	0.2515	0.3307
YEAR 1	0.6831	0.5512	0.4585	0.2543	0.2198	0.2534	0.1928	0.3120
	504	497	491	473	460	453	448	438
YEAR 2	0.7341	0.6719	0.5658	0.4695	0.2721	0.2141	0.2224	0.2927
	651	650	649	636	626	620	610	596
YEAR 3	0.6341	0.4885	0.3969	0.1843	0.1736	0.0989	0.0880	0.2077
	681	679	677	666	657	649	630	620
YEAR 4	0.6786	0.6119	0.5333	0.4204	0.3469	0.3539	0.3152	0.3088
	611	597	586	555	529	513	522	535
FISHZ	0.6837	0.5854	0.4913	0.3199	0.2516	0.2232	0.2014	0.2769
LINEAR REG	0.5942	0.5638	0.5350	0.4570	0.3904	0.3335	0.2434	0.1776

TOT NUM OBS 1HR COR 2447

NOVEMBER

	HR 1	HR 2	HR 3	HR 6	HR 9	HR 12	HR 18	HR 24
OVERALL	0.6705	0.5790	0.5043	0.3294	0.3085	0.3061	0.2782	0.3293
YEAR 1	0.6309	0.5220	0.4585	0.2596	0.2070	0.1705	0.2087	0.1560
	710	708	706	701	698	695	689	683
YEAR 2	0.6889	0.6183	0.5796	0.4388	0.4441	0.4341	0.3971	0.3518
	661	657	654	647	641	639	629	624
YEAR 3	0.6529	0.5027	0.4000	0.1838	0.1637	0.1705	0.1585	0.3215
	523	520	518	513	507	502	489	477
YEAR 4	0.6061	0.5529	0.4547	0.2755	0.2627	0.2793	0.1751	0.2614
	689	686	683	674	668	662	650	640
FISHZ	0.6446	0.5525	0.4793	0.2972	0.2774	0.2706	0.2408	0.2711
LINEAR REG	0.5618	0.5358	0.5110	0.4434	0.3847	0.3337	0.2512	0.1891

TOT NUM OBS 1HR COR 2583

DECEMBER

	HR 1	HR 2	HR 3	HR 6	HR 9	HR 12	HR 18	HR 24
OVERALL	0.6799	0.5342	0.4574	0.2883	0.2242	0.1835	0.1758	0.1421
YEAR 1	0.7638	0.6016	0.4753	0.2480	0.1284	0.1132	0.2325	0.2198
	492	490	486	481	475	468	456	444
YEAR 2	0.6461	0.4693	0.4015	0.2475	0.1513	0.1002	0.0532	0.0215
	716	714	712	708	709	708	701	697
YEAR 3	0.6555	0.5351	0.5279	0.3899	0.4027	0.3170	0.2615	0.2394
	735	734	733	730	727	724	718	712
YEAR 4	0.6457	0.5220	0.3982	0.2228	0.1651	0.1631	0.1240	0.0586
	738	736	735	732	729	726	720	714
FISHZ	0.6730	0.5275	0.4507	0.2816	0.2239	0.1814	0.1632	0.1262
LINEAR REG	0.5974	0.5448	0.4969	0.3770	0.2860	0.2170	0.1249	0.0719

TOT NUM OBS 1HR COR 2681

SERIAL CORRELATION COEFFICIENTS AND EXPONENTIAL DECAY FUNCTIONS
YPENBURG 10M WIND SPEED (M/SEC)

JANUARY

	HR 1	HR 2	HR 3	HR 6	HR 9	HR 12	HR 18	HR 24
OVERALL	0.7872	0.7579	0.7209	0.5910	0.4737	0.4036	0.2737	0.1606
YEAR 1	0.6701	0.6613	0.6185	0.4843	0.3161	0.2339	0.0879	0.0696
	666	659	652	637	629	618	609	603
YEAR 2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0	0	0	0	0	0	0	0
YEAR 3	0.8517	0.7925	0.7552	0.5778	0.4787	0.4184	0.2728	0.1865
	705	702	699	690	681	672	666	660
YEAR 4	0.8948	0.8481	0.8133	0.7003	0.6273	0.5566	0.4391	0.3673
	521	519	517	511	505	499	487	475
FISHZ	0.8190	0.7724	0.7330	0.5862	0.4730	0.4010	0.2603	0.1984
LINEAR REG	0.8223	0.7700	0.7211	0.5922	0.4863	0.3994	0.2693	0.1816

TOT NUM OBS 1HR COR 1892

FEBRUARY

	HR 1	HR 2	HR 3	HR 6	HR 9	HR 12	HR 18	HR 24
OVERALL	0.9068	0.8620	0.8225	0.6985	0.5917	0.5134	0.3659	0.2549
YEAR 1	0.8781	0.8138	0.7647	0.6008	0.4939	0.4012	0.2227	0.0299
	621	616	612	601	598	595	583	571
YEAR 2	0.9207	0.8835	0.8485	0.7358	0.5986	0.4949	0.3008	0.2087
	593	589	585	573	561	550	535	523
YEAR 3	0.8803	0.8215	0.7653	0.6047	0.4747	0.3986	0.2609	0.1669
	661	658	655	646	637	628	622	616
YEAR 4	0.9266	0.8961	0.8684	0.7830	0.7169	0.6756	0.5922	0.5204
	556	553	550	541	533	527	515	503
FISHZ	0.9026	0.8560	0.8144	0.6848	0.5735	0.4953	0.3464	0.2315
LINEAR REG	0.9080	0.8577	0.8102	0.6829	0.5756	0.4851	0.3446	0.2448

TOT NUM OBS 1HR COR 2431

MARCH

	HR 1	HR 2	HR 3	HR 6	HR 9	HR 12	HR 18	HR 24
OVERALL	0.9062	0.8589	0.8132	0.6806	0.5850	0.4867	0.3384	0.2637
YEAR 1	0.8854	0.8271	0.7685	0.6393	0.5144	0.3827	0.1793	0.1272
	374	372	370	361	354	348	336	324
YEAR 2	0.9349	0.8878	0.8463	0.7087	0.6069	0.5267	0.4290	0.4132
	599	590	582	566	554	542	523	512
YEAR 3	0.8824	0.8310	0.7767	0.6312	0.5342	0.4102	0.2013	0.0719
	699	695	691	682	674	668	661	652
YEAR 4	0.8901	0.8484	0.8089	0.6764	0.6011	0.5185	0.4015	0.3023
	684	681	678	669	660	651	639	627
FISHZ	0.9011	0.8516	0.8044	0.6662	0.5700	0.4686	0.3165	0.2362
LINEAR REG	0.9033	0.8511	0.8019	0.6708	0.5610	0.4693	0.3283	0.2297

TOT NUM OBS 1HR COR 2356

APRIL

	HR 1	HR 2	HR 3	HR 6	HR 9	HR 12	HR 18	HR 24
OVERALL	0.8832	0.8297	0.7841	0.6672	0.5728	0.4998	0.4593	0.4099
YEAR 1	0.9061	0.8550	0.8072	0.6745	0.5652	0.5224	0.5660	0.5317
	548	545	542	533	524	515	499	487
YEAR 2	0.8328	0.7567	0.7120	0.5690	0.4440	0.3285	0.2689	0.2804
	695	692	689	680	675	672	666	660
YEAR 3	0.8221	0.7485	0.6787	0.5196	0.4333	0.3141	0.1968	0.0759
	670	667	664	655	646	637	628	617
YEAR 4	0.8842	0.8383	0.7964	0.7144	0.6535	0.5526	0.4587	0.3839
	684	681	678	669	661	656	650	644
FISHZ	0.8631	0.8018	0.7507	0.6232	0.5218	0.4308	0.3710	0.3153
LINEAR REG	0.8312	0.7911	0.7530	0.6492	0.5596	0.4827	0.3589	0.2668

TOT NUM OBS 1HR COR 2597

SERIAL CORRELATION COEFFICIENTS AND EXPONENTIAL DECAY FUNCTIONS
YPENBURG 10M WIND SPEED (M/SEC)

MAY

	HR 1	HR 2	HR 3	HR 6	HR 9	HR 12	HR 18	HR 24
OVERALL	0.8690	0.8050	0.7544	0.6262	0.5423	0.4700	0.3981	0.3692
YEAR 1	0.8504	0.7613	0.6963	0.5055	0.3843	0.3281	0.3509	0.3521
	510	506	502	490	478	466	447	429
YEAR 2	0.8134	0.7272	0.6607	0.4604	0.3568	0.3004	0.1548	0.2205
	537	531	526	513	503	494	476	460
YEAR 3	0.8577	0.7863	0.7287	0.5839	0.4724	0.3648	0.2311	0.1470
	706	703	700	691	682	674	668	662
YEAR 4	0.8582	0.8011	0.7522	0.6671	0.6234	0.5507	0.5213	0.4849
	702	698	694	684	675	669	663	657
FISHZ	0.8475	0.7739	0.7156	0.5704	0.4806	0.4031	0.3324	0.3096
LINEAR REG	0.8013	0.7609	0.7226	0.6187	0.5298	0.4537	0.3327	0.2439

TOT NUM OBS 1HR COR 2455

JUNE

	HR 1	HR 2	HR 3	HR 6	HR 9	HR 12	HR 18	HR 24
OVERALL	0.8035	0.7156	0.6273	0.4793	0.3497	0.2993	0.3067	0.2807
YEAR 1	0.7975	0.6640	0.5278	0.3201	0.1437	0.1099	0.2486	0.1637
	581	573	565	548	534	521	497	474
YEAR 2	0.8541	0.8125	0.7474	0.6244	0.5700	0.5559	0.4281	0.4782
	472	468	464	454	446	440	428	416
YEAR 3	0.7500	0.6590	0.5839	0.4783	0.3493	0.2648	0.2615	0.2046
	573	566	562	546	532	518	500	485
YEAR 4	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0	0	0	0	0	0	0	0
FISHZ	0.8011	0.7134	0.6226	0.4744	0.3543	0.3098	0.3094	0.2799
LINEAR REG	0.7296	0.6901	0.6527	0.5523	0.4673	0.3954	0.2831	0.2627

TOT NUM OBS 1HR COR 1626

JULY

	HR 1	HR 2	HR 3	HR 6	HR 9	HR 12	HR 18	HR 24
OVERALL	0.8963	0.8042	0.7471	0.6030	0.4869	0.4060	0.3073	0.2702
YEAR 1	0.8396	0.7735	0.7064	0.5215	0.5570	0.2145	0.0652	0.1094
	647	642	637	622	611	602	584	573
YEAR 2	0.8677	0.8049	0.7513	0.6089	0.5017	0.4287	0.3395	0.2629
	636	631	627	615	604	596	584	572
YEAR 3	0.8632	0.7798	0.7364	0.6059	0.4930	0.4493	0.3615	0.3591
	716	713	710	701	695	689	683	677
YEAR 4	0.8699	0.8069	0.7200	0.5289	0.3943	0.2568	0.1386	0.0299
	566	562	558	546	535	526	508	490
FISHZ	0.8603	0.7909	0.7276	0.5700	0.4417	0.3479	0.2387	0.2073
LINEAR REG	0.8427	0.7835	0.7284	0.5854	0.4705	0.3781	0.2442	0.1577

TOT NUM OBS 1HR COR 2565

AUGUST

	HR 1	HR 2	HR 3	HR 6	HR 9	HR 12	HR 18	HR 24
OVERALL	0.8640	0.8142	0.7654	0.6501	0.5638	0.5025	0.3607	0.2704
YEAR 1	0.8614	0.7884	0.7375	0.5849	0.4742	0.3614	0.1892	0.0316
	671	667	664	658	654	646	634	622
YEAR 2	0.8366	0.8088	0.7581	0.6359	0.5582	0.4750	0.3534	0.3179
	545	541	537	528	524	520	508	496
YEAR 3	0.8185	0.7552	0.6885	0.5710	0.4915	0.4782	0.3044	0.1615
	632	628	624	613	604	595	588	576
YEAR 4	0.8957	0.8595	0.8210	0.7325	0.6545	0.6109	0.4956	0.4614
	707	704	701	692	683	676	670	664
FISHZ	0.8579	0.8079	0.7573	0.6383	0.5508	0.4890	0.3430	0.2524
LINEAR REG	0.8492	0.8054	0.7639	0.6517	0.5560	0.4744	0.3453	0.2513

TOT NUM OBS 1HR COR 2555

SERIAL CORRELATION COEFFICIENTS AND EXPONENTIAL DECAY FUNCTIONS
YPENBURG 10M WIND SPEED (M/SEC)

SEPTEMBER

	HR 1	HR 2	HR 3	HR 6	HR 9	HR 12	HR 18	HR 24
OVERALL	0.8945	0.8406	0.7926	0.6587	0.5775	0.5201	0.4324	0.4005
YEAR 1	0.8504	0.7493	0.6754	0.4304	0.2468	0.1608	0.0892	0.1578
	268	265	263	256	250	243	231	219
YEAR 2	0.8957	0.8418	0.7807	0.6127	0.5379	0.4984	0.3805	0.4162
	651	647	643	631	620	613	601	592
YEAR 3	0.8764	0.8146	0.7793	0.6436	0.5567	0.4509	0.3432	0.2176
	694	691	688	680	674	668	662	656
YEAR 4	0.9113	0.8734	0.8284	0.7405	0.6771	0.6508	0.5897	0.5530
	689	686	683	674	666	660	653	647
FISHZ	0.8909	0.8360	0.7859	0.6480	0.5630	0.5045	0.4123	0.3799
LINEAR REG	0.8546	0.8193	0.7854	0.6920	0.6096	0.5371	0.4169	0.3236

TOT NUM OBS 1HR COR 2302

OCTOBER

	HR 1	HR 2	HR 3	HR 6	HR 9	HR 12	HR 18	HR 24
OVERALL	0.8978	0.8618	0.8271	0.7397	0.6513	0.5794	0.4663	0.3777
YEAR 1	0.8574	0.7806	0.7176	0.6220	0.4957	0.3821	0.1721	0.0730
	408	405	403	397	391	385	375	363
YEAR 2	0.8743	0.8249	0.7912	0.6918	0.5798	0.5138	0.3548	0.1986
	690	687	684	675	669	666	660	654
YEAR 3	0.8503	0.8102	0.7584	0.5997	0.4893	0.3553	0.2227	0.1834
	709	705	701	693	686	681	674	668
YEAR 4	0.9085	0.8810	0.8492	0.7749	0.6884	0.6278	0.5339	0.4214
	719	716	713	704	699	696	690	684
FISHZ	0.8768	0.8333	0.7913	0.6851	0.5783	0.4895	0.3490	0.2439
LINEAR REG	0.8830	0.8365	0.7924	0.6737	0.5727	0.4869	0.3519	0.2544

TOT NUM OBS 1HR COR 2526

NOVEMBER

	HR 1	HR 2	HR 3	HR 6	HR 9	HR 12	HR 18	HR 24
OVERALL	0.9016	0.8614	0.8214	0.7263	0.6383	0.5766	0.4762	0.4342
YEAR 1	0.8667	0.8231	0.7825	0.7025	0.6150	0.5118	0.3780	0.3317
	513	506	499	478	461	449	430	425
YEAR 2	0.8839	0.8411	0.7946	0.7254	0.6666	0.6350	0.5587	0.5680
	681	677	673	661	652	646	640	634
YEAR 3	0.9129	0.8548	0.7989	0.6295	0.4822	0.3757	0.1709	0.0300
	692	689	686	677	669	667	661	654
YEAR 4	0.8971	0.8634	0.8290	0.7383	0.6589	0.6246	0.5769	0.5580
	664	660	656	644	634	625	613	603
FISHZ	0.8929	0.8476	0.8030	0.7004	0.6089	0.5451	0.4349	0.3963
LINEAR REG	0.8717	0.8380	0.8055	0.7155	0.6356	0.5646	0.4454	0.3515

TOT NUM OBS 1HR COR 2550

DECEMBER

	HR 1	HR 2	HR 3	HR 6	HR 9	HR 12	HR 18	HR 24
OVERALL	0.9098	0.8640	0.8142	0.6868	0.5797	0.4988	0.3578	0.3655
YEAR 1	0.9379	0.9111	0.8793	0.8054	0.7457	0.6910	0.5881	0.5414
	563	559	556	547	539	536	529	517
YEAR 2	0.8813	0.8386	0.7901	0.7212	0.6663	0.6366	0.5674	0.5893
	662	658	654	642	633	627	621	615
YEAR 3	0.9044	0.8335	0.7737	0.6307	0.4956	0.4041	0.1886	0.1442
	705	702	699	690	681	672	665	659
YEAR 4	0.8683	0.8273	0.7578	0.5721	0.4200	0.3176	0.2182	0.1785
	706	702	699	690	683	677	667	661
FISHZ	0.8995	0.8537	0.8015	0.6851	0.5862	0.5171	0.3932	0.3671
LINEAR REG	0.8781	0.8401	0.8037	0.7038	0.6163	0.5396	0.4138	0.3173

TOT NUM OBS 1HR COR 2636

SERIAL CORRELATION COEFFICIENTS AND EXPONENTIAL DECAY FUNCTIONS
YPENBURG 2M WIND SPEED (M/SEC)
JANUARY

	HR 1	HR 2	HR 3	HR 6	HR 9	HR 12	HR 18	HR 24
OVERALL	0.7864	0.7439	0.6960	0.5749	0.4739	0.4104	0.3272	0.2969
YEAR 1	0.7233	0.6811	0.6193	0.4678	0.3711	0.3527	0.3192	0.2569
	743	742	741	738	735	732	726	720
YEAR 2	0.7182	0.6908	0.6351	0.5251	0.4582	0.4167	0.3435	0.2943
	716	715	714	711	708	705	699	693
YEAR 3	0.9439	0.8706	0.7961	0.6190	0.5299	0.4659	0.2633	0.0971
	703	700	696	687	681	675	666	661
YEAR 4	0.9675	0.9269	0.8837	0.7574	0.6372	0.5563	0.4639	0.4551
	731	730	729	726	723	721	715	709
FISHZ	0.8870	0.8215	0.7563	0.6047	0.5051	0.4507	0.3511	0.2838
LINEAR REG	0.8527	0.8073	0.7643	0.6486	0.5504	0.4671	0.3364	0.2422

TOT NUM OBS 1HR COR 2893

FEBRUARY

	HR 1	HR 2	HR 3	HR 6	HR 9	HR 12	HR 18	HR 24
OVERALL	0.7489	0.6925	0.6433	0.4954	0.4231	0.3709	0.2809	0.2362
YEAR 1	0.7133	0.6198	0.5168	0.3658	0.2390	0.2065	0.1431	0.1541
	693	692	691	688	685	682	676	670
YEAR 2	0.7903	0.7483	0.7452	0.6225	0.5802	0.5035	0.4330	0.3438
	630	629	628	625	622	619	613	607
YEAR 3	0.9760	0.9375	0.8954	0.7570	0.6578	0.6256	0.6689	0.7034
	633	629	627	619	613	608	597	587
YEAR 4	0.9619	0.9036	0.8405	0.6571	0.5281	0.4565	0.4410	0.4423
	626	626	624	618	612	606	594	582
FISHZ	0.9087	0.8376	0.7775	0.6126	0.5093	0.4537	0.4316	0.4253
LINEAR REG	0.8423	0.8095	0.7779	0.6903	0.6126	0.5436	0.4281	0.3371

TOT NUM OBS 1HR COR 2584

MARCH

	HR 1	HR 2	HR 3	HR 6	HR 9	HR 12	HR 18	HR 24
OVERALL	0.7976	0.7470	0.6952	0.5509	0.4690	0.3956	0.2721	0.2463
YEAR 1	0.7602	0.6945	0.6363	0.4589	0.4212	0.3458	0.2096	0.1439
	737	735	733	730	727	724	719	712
YEAR 2	0.7077	0.6616	0.5897	0.4306	0.3387	0.2794	0.1525	0.1608
	743	742	741	738	735	732	726	720
YEAR 3	0.9513	0.8764	0.8023	0.6454	0.5304	0.4234	0.3455	0.3310
	681	679	678	672	666	660	648	636
YEAR 4	0.9501	0.8939	0.8342	0.6647	0.5220	0.4592	0.4388	0.4347
	661	657	652	645	640	636	626	614
FISHZ	0.8780	0.8000	0.7269	0.5530	0.4523	0.3751	0.2835	0.2638
LINEAR REG	0.8353	0.7840	0.7359	0.6085	0.5032	0.4161	0.2846	0.1946

TOT NUM OBS 1HR COR 2822

APRIL

	HR 1	HR 2	HR 3	HR 6	HR 9	HR 12	HR 18	HR 24
OVERALL	0.7687	0.7135	0.6621	0.5364	0.4508	0.3869	0.3063	0.2519
YEAR 1	0.7125	0.6254	0.5687	0.3837	0.2751	0.1674	0.0873	0.1075
	717	716	715	712	709	706	700	694
YEAR 2	0.8237	0.7757	0.7387	0.6385	0.5486	0.4958	0.3856	0.2682
	719	718	717	714	711	708	702	696
YEAR 3	0.9542	0.8964	0.8350	0.6900	0.5746	0.4873	0.4893	0.5438
	565	563	561	555	549	543	531	519
YEAR 4	0.9605	0.9028	0.8423	0.6809	0.5724	0.5377	0.5844	0.6020
	717	716	715	712	709	706	700	694
FISHZ	0.8956	0.8215	0.7596	0.6054	0.4967	0.4278	0.3948	0.3880
LINEAR REG	0.8342	0.7982	0.7637	0.6691	0.5862	0.5136	0.3942	0.3026

TOT NUM OBS 1HR COR 2718

SERIAL CORRELATION COEFFICIENTS AND EXPONENTIAL DECAY FUNCTIONS
YPENBURG 2M WIND SPEED (M/SEC)

MAY

	HR 1	HR 2	HR 3	HR 6	HR 9	HR 12	HR 18	HR 24
OVERALL	0.3833	0.4658	0.3026	0.2065	0.0542	-0.0850	0.0955	0.4195
YEAR 1	0.4128	0.4416	0.3112	0.1986	0.0558	0.0817	0.0473	0.3183
	739	738	737	734	731	728	722	716
YEAR 2	0.2941	0.4279	0.2258	0.1766	0.0265	0.1056	0.1039	0.4639
	738	736	734	730	727	724	718	712
YEAR 3	0.9563	0.8859	0.8111	0.6219	0.4868	0.4694	0.5659	0.5708
	656	655	654	651	648	645	639	633
YEAR 4	0.9749	0.9379	0.8958	0.7875	0.7174	0.6816	0.6817	0.6721
	625	623	621	615	609	603	591	579
FISHZ	0.8161	0.7498	0.6321	0.4740	0.3376	0.3434	0.3614	0.5073
LINEAR REG	0.7084	0.6892	0.6705	0.6173	0.5683	0.5232	0.4435	0.3760

TOT NUM OBS 1HR COR 2758

JUNE

	HR 1	HR 2	HR 3	HR 6	HR 9	HR 12	HR 18	HR 24
OVERALL	0.6309	0.5881	0.4923	0.3032	0.1281	0.0593	0.2209	0.2891
YEAR 1	0.6217	0.5701	0.4362	0.2138	0.0165	0.0512	0.1234	0.2087
	598	568	538	535	533	529	523	607
YEAR 2	0.6554	0.6561	0.6147	0.3971	0.2047	0.1140	0.3387	0.3602
	351	330	310	306	300	293	279	307
YEAR 3	0.5462	0.4491	0.3238	0.1928	0.0692	0.0417	0.0523	0.1681
	517	489	461	453	447	445	426	485
YEAR 4	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0	0	0	0	0	0	0	0
FISHZ	0.6049	0.5529	0.4462	0.2519	0.0794	0.0624	0.1498	0.2292
LINEAR REG	0.5484	0.5193	0.4917	0.4174	0.3543	0.3008	0.2168	0.1562

TOT NUM OBS 1HR COR 1466

JULY

	HR 1	HR 2	HR 3	HR 6	HR 9	HR 12	HR 18	HR 24
OVERALL	0.6164	0.5648	0.4817	0.3590	0.2389	0.1875	0.1737	0.2132
YEAR 1	0.4811	0.4600	0.3691	0.2221	0.1039	0.0645	0.1482	0.2944
	741	740	739	736	733	730	724	718
YEAR 2	0.7119	0.6521	0.5643	0.4708	0.3498	0.2834	0.1895	0.1844
	716	714	712	706	700	694	682	670
YEAR 3	0.9548	0.8972	0.8401	0.6684	0.5714	0.5421	0.5397	0.5406
	743	742	741	738	735	732	726	720
YEAR 4	0.9445	0.8700	0.7890	0.5432	0.3408	0.3002	0.4333	0.4212
	617	614	611	601	592	583	565	547
FISHZ	0.8484	0.7637	0.6752	0.4910	0.3536	0.3088	0.3349	0.3676
LINEAR REG	0.7632	0.7282	0.6947	0.6033	0.5239	0.4549	0.3431	0.2587

TOT NUM OBS 1HR COR 2817

AUGUST

	HR 1	HR 2	HR 3	HR 6	HR 9	HR 12	HR 18	HR 24
OVERALL	0.6584	0.6280	0.5905	0.4242	0.3156	0.2394	0.2898	0.3916
YEAR 1	0.6247	0.5617	0.5445	0.3493	0.1905	0.0997	0.1448	0.3005
	662	660	658	652	646	640	628	616
YEAR 2	0.6872	0.6839	0.6213	0.4918	0.4122	0.3840	0.3652	0.4141
	743	742	741	738	735	732	726	720
YEAR 3	0.9263	0.8352	0.7423	0.4786	0.2755	0.1758	0.2820	0.3626
	681	678	676	670	664	658	646	634
YEAR 4	0.9254	0.8403	0.7413	0.4705	0.2204	0.1187	0.3095	0.4139
	525	521	517	505	494	483	470	464
FISHZ	0.8268	0.7437	0.6653	0.4497	0.2854	0.2097	0.2787	0.3728
LINEAR REG	0.7418	0.7079	0.6756	0.5871	0.5102	0.4434	0.3349	0.2530

TOT NUM OBS 1HR COR 2611

SERIAL CORRELATION COEFFICIENTS AND EXPONENTIAL DECAY FUNCTIONS
YPENBURG 2M WIND SPEED (M/SEC)

SEPTEMBER

	HR 1	HR 2	HR 3	HR 6	HR 9	HR 12	HR 18	HR 24
OVERALL	0.6352	0.5461	0.4652	0.4136	0.2914	0.2636	0.3033	0.3793
YEAR 1	0.5128	0.4223	0.3178	0.3111	0.1852	0.1475	0.2619	0.3871
	689	687	685	679	673	667	655	643
YEAR 2	0.6825	0.5541	0.4650	0.4519	0.3013	0.3066	0.3669	0.5034
	719	718	717	714	711	708	702	696
YEAR 3	0.9433	0.8645	0.7666	0.5244	0.2739	0.1307	0.1864	0.0430
	103	102	101	98	95	92	86	80
YEAR 4	0.9413	0.8698	0.7978	0.6086	0.4314	0.3351	0.3782	0.4924
	675	673	671	665	659	653	641	632
FISHZ	0.7915	0.6748	0.5741	0.4676	0.3070	0.2597	0.3313	0.4498
LINEAR REC	0.6694	0.6491	0.6293	0.5737	0.5230	0.4767	0.3961	0.3292

TOT NUM OBS 1HR COR 2186

OCTOBER

	HR 1	HR 2	HR 3	HR 6	HR 9	HR 12	HR 18	HR 24
OVERALL	0.6997	0.0616	0.5275	0.4223	0.3409	0.3548	0.2427	0.3714
YEAR 1	0.6514	0.5157	0.3843	0.2589	0.1018	0.1605	0.0189	0.2808
	696	693	691	682	673	664	646	636
YEAR 2	0.6641	0.5589	0.5321	0.3971	0.3048	0.2465	0.1637	0.2050
	743	742	741	738	735	732	726	720
YEAR 3	0.9586	0.9057	0.8522	0.7235	0.6554	0.6297	0.5502	0.5674
	580	578	576	570	564	558	546	536
YEAR 4	0.9624	0.8939	0.8103	0.5441	0.3573	0.2749	0.3128	0.4375
	708	707	706	703	700	697	691	685
FISHZ	0.8717	0.7663	0.6787	0.4889	0.3591	0.3276	0.2597	0.3695
LINEAR REC	0.7773	0.7392	0.7030	0.6046	0.5200	0.4473	0.3309	0.2448

TOT NUM OBS 1HR COR 2727

NOVEMBER

	HR 1	HR 2	HR 3	HR 6	HR 9	HR 12	HR 18	HR 24
OVERALL	0.7630	0.7236	0.6842	0.6110	0.5291	0.4724	0.3761	0.3044
YEAR 1	0.7493	0.7188	0.6638	0.5095	0.3641	0.2844	0.0922	0.0788
	717	716	715	712	709	706	700	694
YEAR 2	0.7376	0.6766	0.6311	0.5553	0.4841	0.4436	0.4388	0.4142
	696	694	692	686	680	674	662	652
YEAR 3	0.9840	0.9662	0.9490	0.9148	0.8890	0.8655	0.8304	0.7816
	719	718	717	714	711	708	702	696
YEAR 4	0.9842	0.9599	0.9329	0.8535	0.7901	0.7544	0.6780	0.6022
	717	716	715	712	709	706	700	694
FISHZ	0.9344	0.8919	0.8527	0.7646	0.6928	0.6473	0.5699	0.5144
LINEAR REC	0.9044	0.8800	0.8562	0.7887	0.7264	0.6691	0.5677	0.4817

TOT NUM OBS 1HR COR 2849

DECEMBER

	HR 1	HR 2	HR 3	HR 6	HR 9	HR 12	HR 18	HR 24
OVERALL	0.7525	0.6995	0.6439	0.5268	0.4512	0.3927	0.2609	0.2142
YEAR 1	0.7111	0.6234	0.5675	0.4228	0.3425	0.3226	0.1393	0.1211
	743	742	741	738	735	732	726	720
YEAR 2	0.6331	0.5904	0.5166	0.3755	0.2660	0.1788	0.0598	0.0063
	740	738	737	734	731	728	722	716
YEAR 3	0.9769	0.9466	0.9113	0.8191	0.7410	0.6825	0.6109	0.5850
	576	574	572	566	560	554	542	530
YEAR 4	0.9844	0.9601	0.9330	0.8539	0.7916	0.7578	0.6851	0.6093
	693	692	691	688	685	682	676	670
FISHZ	0.9081	0.8472	0.7902	0.6576	0.5640	0.5091	0.3896	0.3359
LINEAR REC	0.8767	0.8361	0.7973	0.6916	0.5999	0.5203	0.3914	0.2945

TOT NUM OBS 1HR COR 2752

SERIAL CORRELATION COEFFICIENTS AND EXPONENTIAL DECAY FUNCTIONS
YPENBURG TEMPERATURE (DEG C)

JANUARY

	HR 1	HR 2	HR 3	HR 6	HR 9	HR 12	HR 18	HR 24
OVERALL	0.9583	0.9077	0.8545	0.7091	0.6019	0.5232	0.4248	0.3903
YEAR 1	0.9439	0.8706	0.7961	0.6190	0.5299	0.4559	0.2633	0.0971
	703	700	696	687	681	675	666	661
YEAR 2	0.9675	0.9269	0.8837	0.7574	0.6372	0.5563	0.4639	0.4551
	731	730	729	726	723	721	715	709
YEAR 3	0.9533	0.8906	0.8243	0.6375	0.5126	0.4329	0.3982	0.4483
	743	742	741	738	735	732	726	720
YEAR 4	0.9515	0.9042	0.8543	0.7209	0.6317	0.5383	0.4177	0.3341
	716	715	714	711	708	705	699	693
FISHZ	0.9550	0.9003	0.8431	0.6885	0.5808	0.5001	0.3900	0.3449
LINEAR REG	0.9298	0.8839	0.8403	0.7220	0.6204	0.5330	0.3935	0.2905

TOT NUM OBS 1HR COR 2893

FEBRUARY

	HR 1	HR 2	HR 3	HR 6	HR 9	HR 12	HR 18	HR 24
OVERALL	0.9736	0.9340	0.8887	0.7500	0.6447	0.5942	0.6187	0.6650
YEAR 1	0.9760	0.9375	0.8954	0.7570	0.6578	0.6256	0.6689	0.7034
	633	629	627	619	613	608	597	587
YEAR 2	0.9619	0.9036	0.8405	0.6571	0.5281	0.4565	0.4410	0.4423
	628	626	624	618	612	606	594	582
YEAR 3	0.9587	0.8944	0.8163	0.5695	0.3683	0.2600	0.3281	0.4656
	693	692	691	688	685	682	676	670
YEAR 4	0.9711	0.9335	0.8915	0.7783	0.7016	0.6567	0.6383	0.6504
	630	629	628	625	622	619	613	607
FISHZ	0.9675	0.9188	0.8637	0.6966	0.5726	0.5095	0.5282	0.5740
LINEAR REG	0.8980	0.8723	0.8474	0.7769	0.7123	0.6530	0.5489	0.4613

TOT NUM OBS 1HR COR 2584

MARCH

	HR 1	HR 2	HR 3	HR 6	HR 9	HR 12	HR 18	HR 24
OVERALL	0.9619	0.9097	0.8551	0.7147	0.6075	0.5351	0.5043	0.4915
YEAR 1	0.9513	0.8764	0.8023	0.6454	0.5304	0.4234	0.3455	0.3310
	681	679	678	672	666	660	648	636
YEAR 2	0.9501	0.8939	0.8342	0.6647	0.5220	0.4592	0.4388	0.4347
	661	657	652	645	640	636	626	614
YEAR 3	0.9636	0.9131	0.8580	0.7616	0.5786	0.4722	0.3613	0.2698
	735	733	731	728	725	722	717	710
YEAR 4	0.9566	0.8996	0.8380	0.6619	0.5309	0.4831	0.5602	0.6164
	743	742	741	738	735	732	726	720
FISHZ	0.9559	0.8970	0.8348	0.6695	0.5416	0.4607	0.4329	0.4259
LINEAR REG	0.9037	0.8655	0.8289	0.7281	0.6396	0.5618	0.4335	0.3345

TOT NUM OBS 1HR COR 2820

APRIL

	HR 1	HR 2	HR 3	HR 6	HR 9	HR 12	HR 18	HR 24
OVERALL	0.9640	0.9140	0.8609	0.7144	0.5937	0.5320	0.5708	0.6264
YEAR 1	0.8842	0.8383	0.7964	0.7144	0.6535	0.5526	0.4587	0.3839
	684	681	678	669	661	656	650	644
YEAR 2	0.7456	0.7220	0.6664	0.5323	0.4789	0.4125	0.3241	0.2102
	565	563	561	555	549	543	531	519
YEAR 3	0.6619	0.5591	0.4692	0.3259	0.1990	0.1449	0.1105	0.1818
	717	716	715	712	709	706	700	694
YEAR 4	0.7125	0.6254	0.5687	0.3837	0.2751	0.1674	0.0873	0.1075
	717	716	715	712	709	706	700	694
FISHZ	0.7656	0.6996	0.6381	0.5008	0.4104	0.3209	0.2428	0.2212
LINEAR REG	0.7351	0.6892	0.6462	0.5325	0.4389	0.3617	0.2456	0.1668

TOT NUM OBS 1HR COR 2683

SERIAL CORRELATION COEFFICIENTS AND EXPONENTIAL DECAY FUNCTIONS
YPENBURG TEMPERATURE (DEG C)

MAY

	HR 1	HR 2	HR 3	HR 6	HR 9	HR 12	HR 18	HR 24
OVERALL	0.9790	0.9325	0.8965	0.7752	0.6953	0.6682	0.6954	0.7036
YEAR 1	0.9563	0.8859	0.8111	0.6219	0.4868	0.4694	0.5659	0.5708
	656	655	654	651	648	645	639	633
YEAR 2	0.9749	0.9379	0.8958	0.7875	0.7174	0.6816	0.6817	0.6721
	625	623	621	615	609	603	591	579
YEAR 3	0.9766	0.9475	0.9184	0.8384	0.7855	0.7628	0.7560	0.7563
	739	738	737	734	731	728	722	716
YEAR 4	0.9659	0.9205	0.8695	0.7078	0.5895	0.5481	0.6260	0.6758
	738	736	734	730	727	724	718	712
FISHZ	0.9695	0.9266	0.8802	0.7515	0.6617	0.6310	0.6653	0.6770
LINEAR REG	0.9003	0.8841	0.8682	0.8222	0.7786	0.7373	0.6612	0.5930

TOT NUM OBS 1HR COR 2758

JUNE

	HR 1	HR 2	HR 3	HR 6	HR 9	HR 12	HR 18	HR 24
OVERALL	0.9450	0.8778	0.8060	0.6268	0.5103	0.4361	0.4088	0.4397
YEAR 1	0.9449	0.8669	0.7852	0.5889	0.4872	0.4057	0.2910	0.3368
	713	711	710	707	704	701	695	689
YEAR 2	0.9595	0.9053	0.8469	0.6892	0.5769	0.5244	0.6095	0.6928
	423	420	417	408	399	390	373	355
YEAR 3	0.9194	0.8452	0.7634	0.5556	0.4134	0.3209	0.2888	0.2276
	624	621	618	609	600	591	573	557
YEAR 4	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0	0	0	0	0	0	0	0
FISHZ	0.9414	0.8704	0.7946	0.6068	0.4846	0.4063	0.3726	0.3972
LINEAR REG	0.8768	0.8357	0.7965	0.6897	0.5972	0.5171	0.3877	0.2907

TOT NUM OBS 1HR COR 1760

JULY

	HR 1	HR 2	HR 3	HR 6	HR 9	HR 12	HR 18	HR 24
OVERALL	0.9614	0.9088	0.8526	0.6860	0.5600	0.5064	0.5612	0.5984
YEAR 1	0.9548	0.8972	0.8401	0.6684	0.5714	0.5421	0.5397	0.5406
	743	742	741	738	735	732	726	720
YEAR 2	0.9445	0.8700	0.7890	0.5432	0.3408	0.3002	0.4333	0.4212
	617	614	611	601	592	583	565	547
YEAR 3	0.9493	0.8789	0.8014	0.5727	0.3881	0.2957	0.3830	0.4841
	741	740	739	736	733	730	724	718
YEAR 4	0.9680	0.9215	0.8706	0.7222	0.6972	0.5380	0.5982	0.6428
	716	714	712	706	700	694	682	670
FISHZ	0.9554	0.8944	0.8293	0.6351	0.4904	0.4315	0.4950	0.5313
LINEAR REG	0.8733	0.8453	0.8183	0.7422	0.6732	0.6106	0.5023	0.4132

TOT NUM OBS 1HR COR 2817

AUGUST

	HR 1	HR 2	HR 3	HR 6	HR 9	HR 12	HR 18	HR 24
OVERALL	0.9455	0.8781	0.8066	0.6086	0.4517	0.3806	0.4686	0.5367
YEAR 1	0.9263	0.8352	0.7423	0.4786	0.2755	0.1758	0.2820	0.3626
	681	678	676	670	664	658	646	634
YEAR 2	0.9254	0.8403	0.7413	0.4705	0.2204	0.1187	0.3095	0.4139
	525	521	517	505	494	483	470	464
YEAR 3	0.9299	0.8430	0.7553	0.5212	0.3625	0.2561	0.2940	0.4623
	662	660	658	652	646	640	628	616
YEAR 4	0.9563	0.8849	0.8149	0.6145	0.4475	0.3874	0.4869	0.5083
	743	742	741	738	735	732	726	720
FISHZ	0.9348	0.8539	0.7681	0.5296	0.3396	0.2498	0.3541	0.4425
LINEAR REG	0.8437	0.8077	0.7733	0.6784	0.5953	0.5223	0.4020	0.3095

TOT NUM OBS 1HR COR 2611

SERIAL CORRELATION COEFFICIENTS AND EXPONENTIAL DECAY FUNCTIONS
YPENBURG TEMPERATURE (DEG C)

SEPTEMBER

	HR 1	HR 2	HR 3	HR 6	HR 9	HR 12	HR 18	HR 24
OVERALL	0.9592	0.9042	0.8474	0.6905	0.5617	0.4845	0.4890	0.5206
YEAR 1	0.9433	0.8645	0.7666	0.5244	0.2739	0.1307	0.1864	0.0430
	103	102	101	98	95	92	86	80
YEAR 2	0.9413	0.8698	0.7978	0.6086	0.4314	0.3351	0.3782	0.4924
	675	673	671	665	659	653	641	632
YEAR 3	0.9721	0.9316	0.8878	0.7554	0.6541	0.5806	0.5108	0.4533
	660	657	654	645	636	627	609	592
YEAR 4	0.9315	0.8373	0.7449	0.4964	0.3072	0.2048	0.3056	0.4541
	719	718	717	714	711	708	702	696
FISHZ	0.9508	0.8841	0.8152	0.6238	0.4637	0.3681	0.3890	0.4525
LINEAR REG	0.8796	0.8426	0.8072	0.7096	0.6238	0.5483	0.4237	0.3275

TOT NUM OBS 1HR COR 2157

OCTOBER

	HR 1	HR 2	HR 3	HR 6	HR 9	HR 12	HR 18	HR 24
OVERALL	0.9714	0.9303	0.8858	0.7628	0.6795	0.6357	0.5960	0.6103
YEAR 1	0.9586	0.9057	0.8522	0.7225	0.6554	0.6297	0.5502	0.5674
	580	578	576	570	564	558	546	536
YEAR 2	0.9624	0.8939	0.8103	0.5441	0.3573	0.2749	0.3128	0.4375
	708	707	706	703	700	697	691	685
YEAR 3	0.9843	0.9633	0.9415	0.8384	0.8477	0.8222	0.7975	0.7878
	698	695	693	684	675	666	648	638
YEAR 4	0.9661	0.9211	0.8741	0.7461	0.6561	0.5978	0.5104	0.4806
	743	742	741	738	735	732	726	720
FISHZ	0.9701	0.9270	0.8802	0.7509	0.6609	0.6121	0.5666	0.5838
LINEAR REG	0.9181	0.8942	0.8708	0.8045	0.7432	0.6866	0.5860	0.5001

TOT NUM OBS 1HR COR 2729

NOVEMBER

	HR 1	HR 2	HR 3	HR 6	HR 9	HR 12	HR 18	HR 24
OVERALL	0.9825	0.9606	0.9368	0.8730	0.8258	0.7955	0.7638	0.7320
YEAR 1	0.9840	0.9662	0.9490	0.9148	0.8890	0.8655	0.8304	0.7816
	719	718	717	714	711	708	702	696
YEAR 2	0.9842	0.9599	0.9329	0.8535	0.7901	0.7544	0.6780	0.6922
	717	716	715	712	709	706	700	694
YEAR 3	0.9591	0.9101	0.8546	0.7154	0.6162	0.5380	0.5098	0.5284
	717	716	715	712	709	706	700	694
YEAR 4	0.9875	0.9730	0.9566	0.9055	0.8710	0.8559	0.8586	0.8550
	696	694	692	686	680	674	662	652
FISHZ	0.9810	0.9572	0.9313	0.8629	0.8125	0.7786	0.7452	0.7146
LINEAR REG	0.9538	0.9399	0.9263	0.8865	0.8484	0.8119	0.7437	0.6811

TOT NUM OBS 1HR COR 2849

DECEMBER

	HR 1	HR 2	HR 3	HR 6	HR 9	HR 12	HR 18	HR 24
OVERALL	0.9813	0.9567	0.9302	0.8566	0.7963	0.7468	0.6809	0.6418
YEAR 1	0.9769	0.9466	0.9113	0.8191	0.7410	0.6825	0.6109	0.5850
	576	574	572	566	560	554	542	530
YEAR 2	0.9844	0.9601	0.9330	0.8539	0.7916	0.7578	0.6851	0.6093
	693	692	691	688	685	682	676	670
YEAR 3	0.9849	0.9632	0.9417	0.8830	0.8245	0.7699	0.7150	0.6942
	743	742	741	738	735	732	726	720
YEAR 4	0.9686	0.9328	0.8971	0.8056	0.7447	0.6984	0.5937	0.4818
	740	738	737	734	731	728	722	716
FISHZ	0.9794	0.9522	0.9232	0.8444	0.7799	0.7317	0.6564	0.5987
LINEAR REG	0.9624	0.9410	0.9201	0.8600	0.8039	0.7514	0.6565	0.5736

TOT NUM OBS 1HR COR 2752

SERIAL CORRELATION COEFFICIENTS AND EXPONENTIAL DECAY FUNCTIONS
YPENBURG DEWPOINT (DEG C)

JANUARY

	HR 1	HR 2	HR 3	HR 6	HR 9	HR 12	HR 18	HR 24
OVERALL	0.9545	0.8968	0.8350	0.6695	0.5412	0.4422	0.3411	0.3049
YEAR 1	0.9413	0.8645	0.7795	0.5470	0.3808	0.2584	0.0595	0.0655
	703	700	696	687	681	675	666	661
YEAR 2	0.9566	0.9010	0.8441	0.6965	0.5681	0.4715	0.3786	0.3588
	731	730	729	726	723	721	715	709
YEAR 3	0.9539	0.8800	0.8009	0.5812	0.4654	0.3960	0.4111	0.5234
	743	742	741	738	735	732	726	720
YEAR 4	0.9591	0.9199	0.8775	0.7632	0.6443	0.5315	0.3866	0.2712
	716	715	714	711	708	705	699	693
FISHZ	0.9532	0.8934	0.8295	0.6564	0.5228	0.4210	0.3188	0.3193
LINEAR REG	0.9259	0.8729	0.8229	0.6896	0.5779	0.4843	0.3401	0.2388

TOT NUM OBS 1HR COR 2893

FEBRUARY

	HR 1	HR 2	HR 3	HR 6	HR 9	HR 12	HR 18	HR 24
OVERALL	0.9721	0.9308	0.8840	0.7338	0.6092	0.5387	0.5397	0.5637
YEAR 1	0.9644	0.9098	0.8502	0.6362	0.4685	0.4129	0.5565	0.6571
	633	629	627	619	613	608	597	587
YEAR 2	0.9567	0.8960	0.8330	0.6797	0.5481	0.4035	0.1930	0.1142
	628	626	624	618	612	606	594	582
YEAR 3	0.9765	0.9398	0.8977	0.7559	0.6169	0.5144	0.4485	0.4235
	693	692	691	688	685	682	676	670
YEAR 4	0.9683	0.9233	0.8680	0.7037	0.5816	0.5113	0.4907	0.5065
	630	629	628	625	622	619	613	607
FISHZ	0.9675	0.9194	0.8652	0.6982	0.5580	0.4640	0.4319	0.4451
LINEAR REG	0.9247	0.8860	0.8490	0.7469	0.6571	0.5781	0.4474	0.3463

TOT NUM OBS 1HR COR 2584

MARCH

	HR 1	HR 2	HR 3	HR 6	HR 9	HR 12	HR 18	HR 24
OVERALL	0.9724	0.9374	0.8998	0.7930	0.6943	0.6102	0.5109	0.4345
YEAR 1	0.9735	0.9352	0.8966	0.7896	0.6925	0.6134	0.5604	0.5115
	681	679	676	672	666	660	648	636
YEAR 2	0.9543	0.9009	0.8466	0.6857	0.5453	0.4394	0.3031	0.2224
	661	657	652	645	640	636	626	614
YEAR 3	0.9676	0.9273	0.8810	0.7458	0.5970	0.4342	0.1563	0.0039
	735	733	731	728	725	722	717	710
YEAR 4	0.9774	0.9565	0.9195	0.8335	0.7633	0.7183	0.6897	0.6282
	738	736	735	732	729	726	720	714
FISHZ	0.9696	0.9312	0.8897	0.7710	0.6605	0.5667	0.4546	0.3666
LINEAR REG	0.9666	0.9243	0.8838	0.7726	0.6755	0.5905	0.4514	0.3450

TOT NUM OBS 1HR COR 2815

APRIL

	HR 1	HR 2	HR 3	HR 6	HR 9	HR 12	HR 18	HR 24
OVERALL	0.9700	0.9375	0.9059	0.8184	0.7445	0.6799	0.5715	0.5014
YEAR 1	0.9781	0.9329	0.9260	0.8424	0.7756	0.7226	0.6359	0.5339
	565	563	561	553	549	543	531	519
YEAR 2	0.9708	0.9411	0.9144	0.8410	0.7894	0.7374	0.6347	0.5403
	717	716	715	712	709	706	700	694
YEAR 3	0.9575	0.9075	0.8593	0.7313	0.6295	0.5238	0.3706	0.3617
	717	716	715	712	709	706	700	694
YEAR 4	0.9556	0.9119	0.8693	0.7584	0.6451	0.5369	0.3801	0.3017
	717	716	715	712	709	706	700	694
FISHZ	0.9661	0.9295	0.8939	0.7956	0.7108	0.6354	0.5087	0.4335
LINEAR REG	0.9601	0.9258	0.8927	0.8004	0.7176	0.6434	0.5172	0.4158

TOT NUM OBS 1HR COR 2716

SERIAL CORRELATION COEFFICIENTS AND EXPONENTIAL DECAY FUNCTIONS
YPENBURG DEWPOINT (DEG C)
MAY

	HR 1	HR 2	HR 3	HR 6	HR 9	HR 12	HR 18	HR 24
OVERALL	0.9737	0.9449	0.9168	0.8443	0.7820	0.7281	0.6789	0.6589
YEAR 1	0.9420	0.8831	0.8318	0.7147	0.6224	0.5472	0.3962	0.2933
	656	655	654	651	648	645	639	633
YEAR 2	0.9682	0.9308	0.8908	0.7962	0.7319	0.6720	0.6126	0.5723
	625	623	621	615	609	603	591	579
YEAR 3	0.9822	0.9643	0.9466	0.8998	0.8565	0.8158	0.7807	0.7858
	735	734	733	730	727	724	719	714
YEAR 4	0.9664	0.9254	0.8828	0.7718	0.6671	0.5868	0.5656	0.5276
	738	736	734	730	727	724	718	712
FISHZ	0.9681	0.9327	0.8976	0.8104	0.7367	0.6735	0.6105	0.5789
LINEAR REG	0.9398	0.9168	0.8945	0.8306	0.7713	0.7162	0.6176	0.5326

TOT NUM OBS 1HR COR 2754

JUNE

	HR 1	HR 2	HR 3	HR 6	HR 9	HR 12	HR 18	HR 24
OVERALL	0.9378	0.8863	0.8228	0.6876	0.5824	0.5048	0.3838	0.2764
YEAR 1	0.9488	0.8933	0.8460	0.7321	0.6455	0.6068	0.5506	0.4812
	423	420	417	408	399	390	373	355
YEAR 2	0.8947	0.8447	0.7502	0.6105	0.4937	0.3788	0.2607	0.0946
	568	557	548	529	515	505	489	483
YEAR 3	0.4702	0.3058	0.2705	0.0781	0.0929	0.1677	0.0483	0.0270
	710	707	706	703	700	697	693	687
YEAR 4	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0	0	0	0	0	0	0	0
FISHZ	0.8169	0.7163	0.6327	0.4575	0.3820	0.3563	0.2483	0.1626
LINEAR REG	0.7673	0.7124	0.6614	0.5293	0.4236	0.3390	0.2171	0.1390

TOT NUM OBS 1HR COR 1701

JULY

	HR 1	HR 2	HR 3	HR 6	HR 9	HR 12	HR 18	HR 24
OVERALL	0.9639	0.9268	0.8922	0.8055	0.7437	0.6967	0.6300	0.5664
YEAR 1	0.9555	0.9072	0.8669	0.7857	0.7398	0.6957	0.6425	0.5826
	743	742	741	738	735	732	726	720
YEAR 2	0.9385	0.8745	0.8119	0.6630	0.5680	0.5098	0.3831	0.2893
	617	614	611	601	592	583	565	547
YEAR 3	0.9633	0.9263	0.8924	0.7989	0.7336	0.6914	0.6349	0.5321
	644	632	621	592	573	565	562	577
YEAR 4	0.9701	0.9423	0.9133	0.8301	0.7573	0.7010	0.6317	0.5832
	716	714	712	706	700	694	682	670
FISHZ	0.9588	0.9168	0.8773	0.7789	0.7105	0.6600	0.5881	0.5151
LINEAR REG	0.9298	0.9041	0.8790	0.8081	0.7428	0.6829	0.5771	0.4877

TOT NUM OBS 1HR COR 2720

AUGUST

	HR 1	HR 2	HR 3	HR 6	HR 9	HR 12	HR 18	HR 24
OVERALL	0.9590	0.9222	0.8857	0.7815	0.7058	0.6608	0.5807	0.5043
YEAR 1	0.9442	0.8880	0.8347	0.7067	0.6052	0.5410	0.4877	0.3938
	679	676	674	668	662	656	644	632
YEAR 2	0.9188	0.8530	0.7949	0.6219	0.4981	0.4513	0.3942	0.3295
	525	521	517	505	494	483	470	464
YEAR 3	0.9348	0.8916	0.8431	0.6942	0.6356	0.6320	0.4692	0.3299
	443	419	398	349	321	307	319	339
YEAR 4	0.9734	0.9442	0.9134	0.8189	0.7385	0.6768	0.5763	0.4990
	743	742	741	738	735	732	726	720
FISHZ	0.9504	0.9047	0.8595	0.7315	0.6386	0.5862	0.4975	0.4078
LINEAR REG	0.9260	0.8908	0.8570	0.7631	0.6795	0.6051	0.4797	0.3804

TOT NUM OBS 1HR COR 2390

SERIAL CORRELATION COEFFICIENTS AND EXPONENTIAL DECAY FUNCTIONS
YPENBURG DEWPOINT (DEG C)

SEPTEMBER

	HR 1	HR 2	HR 3	HR 6	HR 9	HR 12	HR 18	HR 24
OVERALL	0.9746	0.9453	0.9151	0.8368	0.7701	0.7094	0.6015	0.5130
YEAR 1	0.9584	0.8986	0.8429	0.7437	0.6617	0.5795	0.4353	0.1578
	103	102	101	98	95	92	86	80
YEAR 2	0.9596	0.9123	0.8641	0.7422	0.6494	0.5736	0.3940	0.2714
	675	673	671	665	659	653	641	632
YEAR 3	0.9838	0.9673	0.9489	0.8971	0.8473	0.7966	0.7003	0.5863
	643	639	633	623	612	603	585	568
YEAR 4	0.9550	0.9011	0.8459	0.6957	0.5635	0.4480	0.3239	0.2930
	700	697	694	688	683	678	672	666
FISHZ	0.9682	0.9316	0.8932	0.7911	0.7018	0.6207	0.4812	0.3771
LINEAR REG	0.9701	0.9312	0.8938	0.7905	0.6992	0.6184	0.4837	0.3784

TOT NUM OBS 1HR COR 2121

OCTOBER

	HR 1	HR 2	HR 3	HR 6	HR 9	HR 12	HR 18	HR 24
OVERALL	0.9785	0.9503	0.9201	0.8327	0.7576	0.6985	0.6407	0.6040
YEAR 1	0.9612	0.9118	0.8570	0.6960	0.5837	0.5187	0.4771	0.5150
	580	578	576	570	564	558	546	536
YEAR 2	0.9661	0.9153	0.8589	0.7095	0.5684	0.4579	0.3556	0.2763
	708	707	706	703	700	697	691	685
YEAR 3	0.9917	0.9815	0.9710	0.9371	0.9033	0.8717	0.8399	0.8265
	698	695	693	684	675	666	648	638
YEAR 4	0.9661	0.9254	0.8826	0.7572	0.6613	0.5873	0.5097	0.3933
	611	597	586	555	529	513	522	535
FISHZ	0.9760	0.9447	0.9107	0.8105	0.7229	0.6539	0.5883	0.5478
LINEAR REG	0.9536	0.9273	0.9017	0.8289	0.7621	0.7006	0.5921	0.5005

TOT NUM OBS 1HR COR 2597

NOVEMBER

	HR 1	HR 2	HR 3	HR 6	HR 9	HR 12	HR 18	HR 24
OVERALL	0.9806	0.9558	0.9302	0.8604	0.8067	0.7650	0.7032	0.6541
YEAR 1	0.9753	0.9453	0.9160	0.8505	0.8098	0.7829	0.7197	0.6746
	719	718	717	714	711	708	702	696
YEAR 2	0.9803	0.9530	0.9221	0.8332	0.7667	0.7130	0.6110	0.5400
	717	716	715	712	709	706	700	694
YEAR 3	0.9606	0.9174	0.8733	0.7245	0.5816	0.4725	0.3846	0.3556
	717	716	715	712	709	706	700	694
YEAR 4	0.9874	0.9696	0.9516	0.9021	0.8628	0.8300	0.7954	0.7512
	696	694	692	686	680	674	662	652
FISHZ	0.9777	0.9493	0.9199	0.8372	0.7716	0.7205	0.6487	0.5970
LINEAR REG	0.9584	0.9367	0.9156	0.8550	0.7984	0.7455	0.6500	0.5668

TOT NUM OBS 1HR COR 2849

DECEMBER

	HR 1	HR 2	HR 3	HR 6	HR 9	HR 12	HR 18	HR 24
OVERALL	0.9792	0.9508	0.9200	0.8311	0.7595	0.7035	0.6212	0.5947
YEAR 1	0.9741	0.9401	0.9074	0.8142	0.7356	0.6660	0.5692	0.5250
	576	574	572	566	560	554	542	530
YEAR 2	0.9802	0.9523	0.9209	0.8309	0.7642	0.7113	0.6101	0.5361
	693	692	691	688	685	682	676	670
YEAR 3	0.9807	0.9566	0.9301	0.8547	0.7848	0.7235	0.6634	0.6637
	743	742	741	738	735	732	726	720
YEAR 4	0.9726	0.9369	0.8974	0.7894	0.7172	0.6597	0.5227	0.4570
	740	738	737	734	731	728	722	716
FISHZ	0.[illegible]773	0.9474	0.9152	0.8243	0.7524	0.6924	0.5953	0.5524
LINEAR REG	0.9611	0.9356	0.9107	0.8399	0.7746	0.7144	0.6077	0.5169

TOT NUM OBS 1HR COR 2752

SERIAL CORRELATION COEFFICIENTS AND EXPONENTIAL DECAY FUNCTIONS
YPENBURG RELATIVE HUMIDITY (100% - RH)

JANUARY

	HR 1	HR 2	HR 3	HR 6	HR 9	HR 12	HR 18	HR 24
OVERALL	0.9222	0.8382	0.7535	0.5564	0.4336	0.3653	0.2872	0.2202
YEAR 1	0.9280	0.8358	0.7411	0.5133	0.3473	0.2358	0.1521	0.1025
	703	700	696	687	681	675	666	661
YEAR 2	0.9226	0.8401	0.7557	0.5384	0.3910	0.3193	0.2812	0.2018
	731	730	729	726	723	721	715	709
YEAR 3	0.9153	0.8139	0.7117	0.5322	0.4642	0.4282	0.2642	0.1621
	743	742	741	738	735	732	726	720
YEAR 4	0.8976	0.8059	0.7164	0.4931	0.3544	0.2802	0.1965	0.1344
	716	715	714	711	708	705	699	693
FISHZ	0.9166	0.8244	0.7316	0.5197	0.3914	0.3198	0.2257	0.1514
LINEAR REG	0.8885	0.8122	0.7425	0.5673	0.4335	0.3312	0.1933	0.1129

TOT NUM OBS 1HR COR 2893

FEBRUARY

	HR 1	HR 2	HR 3	HR 6	HR 9	HR 12	HR 18	HR 24
OVERALL	0.9475	0.8771	0.8053	0.6081	0.4436	0.3225	0.1841	0.1878
YEAR 1	0.9484	0.8776	0.8063	0.6365	0.5041	0.4165	0.2933	0.1680
	633	629	627	619	613	608	597	587
YEAR 2	0.9625	0.9058	0.8424	0.6724	0.5253	0.3831	0.1433	0.1193
	628	626	624	618	612	606	594	582
YEAR 3	0.9404	0.8604	0.7865	0.5741	0.3679	0.2041	0.0077	0.0319
	693	692	691	688	685	682	676	670
YEAR 4	0.9015	0.7859	0.6676	0.3294	0.0673	0.0699	0.0426	0.0599
	630	629	628	625	622	619	613	607
FISHZ	0.9418	0.8632	0.7831	0.5651	0.3768	0.2709	0.1194	0.0926
LINEAR REG	0.9597	0.8583	0.7675	0.5490	0.3926	0.2808	0.1437	0.0735

TOT NUM OBS 1HR COR 2584

MARCH

	HR 1	HR 2	HR 3	HR 6	HR 9	HR 12	HR 18	HR 24
OVERALL	0.9219	0.8184	0.7230	0.4763	0.2686	0.1329	0.1067	0.1724
YEAR 1	0.9304	0.8340	0.7416	0.5621	0.4085	0.2728	0.1576	0.1710
	681	679	678	672	666	660	648	636
YEAR 2	0.8953	0.7582	0.6388	0.2887	0.0019	0.1266	0.0156	0.0843
	661	657	652	645	640	636	626	614
YEAR 3	0.9179	0.8087	0.7165	0.4632	0.2381	0.0602	0.0398	0.0052
	735	733	731	728	725	722	717	710
YEAR 4	0.9213	0.8207	0.7150	0.4217	0.1913	0.0882	0.1698	0.3216
	738	736	735	732	729	726	720	714
FISHZ	0.9174	0.8078	0.7059	0.4406	0.2166	0.1352	0.0974	0.1497
LINEAR REG	0.8884	0.7915	0.7052	0.4987	0.3526	0.2494	0.1247	0.0624

TOT NUM OBS 1HR COR 2815

APRIL

	HR 1	HR 2	HR 3	HR 6	HR 9	HR 12	HR 18	HR 24
OVERALL	0.9130	0.8054	0.7013	0.4407	0.2529	0.1615	0.1719	0.2018
YEAR 1	0.9196	0.8147	0.7021	0.4637	0.2256	0.1562	0.1420	0.2435
	565	563	561	555	549	543	531	519
YEAR 2	0.9054	0.7913	0.6783	0.4008	0.2283	0.1438	0.0998	0.1002
	717	716	715	712	709	706	700	694
YEAR 3	0.9140	0.8045	0.7028	0.4576	0.2868	0.1973	0.1538	0.1004
	717	716	715	712	709	706	700	694
YEAR 4	0.9008	0.7836	0.6756	0.3977	0.1322	0.0023	0.1571	0.2987
	717	716	715	712	709	706	700	694
FISHZ	0.9097	0.7979	0.6892	0.4159	0.2185	0.1236	0.1386	0.1834
LINEAR REG	0.8590	0.7770	0.7028	0.5201	0.3849	0.2848	0.1560	0.0854

TOT NUM OBS 1HR COR 2716

SERIAL CORRELATION COEFFICIENTS AND EXPONENTIAL DECAY FUNCTIONS
YPENBURG RELATIVE HUMIDITY (100% - RH)

MAY

	HR 1	HR 2	HR 3	HR 6	HR 9	HR 12	HR 18	HR 24
OVERALL	0.9120	0.8132	0.7210	0.5079	0.3756	0.3356	0.3592	0.4048
YEAR 1	0.9199	0.8165	0.7320	0.5267	0.3644	0.3471	0.4098	0.4978
	656	655	654	651	648	645	639	633
YEAR 2	0.9044	0.7869	0.6678	0.4168	0.2829	0.1956	0.0823	0.0816
	625	623	621	615	609	603	591	579
YEAR 3	0.8648	0.7303	0.6053	0.3305	0.1980	0.1640	0.1799	0.1682
	735	734	733	730	727	724	719	714
YEAR 4	0.9196	0.8231	0.7209	0.4446	0.2161	0.1378	0.2766	0.4628
	738	736	734	730	727	724	718	712
FISHZ	0.9039	0.7911	0.6838	0.4300	0.2630	0.2095	0.2432	0.3187
LINEAR REG	0.8100	0.7614	0.7157	0.5945	0.4939	0.4102	0.2831	0.1953

TOT NUM OBS 1HR COR 2754

JUNE

	HR 1	HR 2	HR 3	HR 6	HR 9	HR 12	HR 18	HR 24
OVERALL	0.8901	0.7595	0.6425	0.3659	0.2120	0.1370	0.1632	0.2775
YEAR 1	0.8988	0.7578	0.6097	0.2605	0.0866	0.0173	0.1064	0.2587
	713	711	710	707	704	701	695	689
YEAR 2	0.8853	0.7727	0.6672	0.4476	0.3040	0.1846	0.2812	0.3485
	423	420	417	408	399	390	373	355
YEAR 3	0.8611	0.6973	0.5766	0.2699	0.0922	0.0267	0.0358	0.0507
	568	557	548	529	515	505	489	483
YEAR 4	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0	0	0	0	0	0	0	0
FISHZ	0.8839	0.7431	0.6143	0.3123	0.1435	0.0622	0.1428	0.2165
LINEAR REG	0.7955	0.7320	0.6735	0.5247	0.4088	0.3184	0.1933	0.1173

TOT NUM OBS 1HR COR 1704

JULY

	HR 1	HR 2	HR 3	HR 6	HR 9	HR 12	HR 18	HR 24
OVERALL	0.8880	0.7607	0.6438	0.3865	0.2104	0.1468	0.2484	0.3358
YEAR 1	0.8727	0.7281	0.5974	0.3019	0.1600	0.1705	0.2544	0.3995
	743	742	741	738	735	732	726	720
YEAR 2	0.8805	0.7283	0.5924	0.3219	0.1112	0.0290	0.1032	0.1357
	617	614	611	601	592	583	565	547
YEAR 3	0.8717	0.7476	0.6260	0.3444	0.1343	0.0270	0.1710	0.2121
	644	632	621	592	573	565	562	577
YEAR 4	0.8914	0.7554	0.6321	0.3638	0.1584	0.0685	0.1882	0.3527
	716	714	712	706	700	694	682	670
FISHZ	0.8794	0.7401	0.6124	0.3328	0.1429	0.0798	0.1850	0.2900
LINEAR REG	0.7742	0.7272	0.6831	0.5661	0.4692	0.3889	0.2671	0.1835

TOT NUM OBS 1HR COR 2720

AUGUST

	HR 1	HR 2	HR 3	HR 6	HR 9	HR 12	HR 18	HR 24
OVERALL	0.8635	0.7395	0.6354	0.3816	0.1575	0.0861	0.1900	0.2832
YEAR 1	0.8897	0.7495	0.6353	0.3518	0.0911	0.0013	0.0951	0.1672
	679	676	674	668	662	656	644	632
YEAR 2	0.8024	0.6522	0.5421	0.2266	0.0456	0.1303	0.0280	0.1609
	525	521	517	505	494	483	470	464
YEAR 3	0.8187	0.6783	0.5632	0.3243	0.0708	0.0176	0.0630	0.2844
	443	419	398	349	321	307	319	339
YEAR 4	0.8731	0.7514	0.6418	0.3392	0.1138	0.0332	0.1879	0.2143
	743	742	741	738	735	732	726	720
FISHZ	0.8558	0.7186	0.6061	0.3163	0.0856	0.0430	0.1075	0.2004
LINEAR REG	0.7761	0.7137	0.6562	0.5102	0.3966	0.3084	0.1864	0.1127

TOT NUM OBS 1HR COR 2390

SERIAL CORRELATION COEFFICIENTS AND EXPONENTIAL DECAY FUNCTIONS
YPENBURG RELATIVE HUMIDITY (100% - RH)

SEPTEMBER

	HR 1	HR 2	HR 3	HR 6	HR 9	HR 12	HR 18	HR 24
OVERALL	0.8791	0.7496	0.6408	0.3855	0.2021	0.1172	0.1633	0.2629
YEAR 1	0.8336	0.6670	0.5171	0.1147	0.2012	0.3539	0.0144	0.0998
	103	102	101	98	95	92	86	80
YEAR 2	0.8773	0.7300	0.6052	0.3164	0.1143	0.0179	0.0477	0.1799
	675	673	671	665	659	653	641	632
YEAR 3	0.8850	0.7769	0.6754	0.3985	0.1843	0.0959	0.2006	0.2652
	643	639	633	623	612	603	585	568
YEAR 4	0.8662	0.7225	0.6154	0.4050	0.2664	0.1897	0.1693	0.2868
	700	697	694	688	683	678	672	666
FISHZ	0.8744	0.7401	0.6271	0.3627	0.1907	0.1146	0.1333	0.2389
LINEAR REG	0.7856	0.7263	0.6714	0.5305	0.4192	0.3312	0.2068	0.1291

TOT NUM OBS 1HR COR 2121

OCTOBER

	HR 1	HR 2	HR 3	HR 6	HR 9	HR 12	HR 18	HR 24
OVERALL	0.8976	0.7796	0.6687	0.4238	0.3069	0.2685	0.2077	0.2338
YEAR 1	0.8801	0.7311	0.5913	0.2811	0.1513	0.1616	0.1924	0.3285
	580	578	576	570	564	558	546	536
YEAR 2	0.9311	0.8300	0.7257	0.4496	0.2656	0.1792	0.0907	0.1004
	708	707	706	703	700	697	691	685
YEAR 3	0.9066	0.8166	0.7344	0.5736	0.4546	0.3683	0.2184	0.1928
	698	695	693	684	675	666	648	638
YEAR 4	0.8285	0.6440	0.4774	0.1418	0.0774	0.1116	0.1257	0.1575
	611	597	586	555	529	513	522	535
FISHZ	0.8948	0.7704	0.6522	0.3888	0.2570	0.2152	0.1562	0.1903
LINEAR REG	0.8280	0.7523	0.6835	0.5127	0.3845	0.2884	0.1622	0.0913

TOT NUM OBS 1HR COR 2597

NOVEMBER

	HR 1	HR 2	HR 3	HR 6	HR 9	HR 12	HR 18	HR 24
OVERALL	0.9249	0.8437	0.7623	0.5683	0.4523	0.3853	0.3452	0.3371
YEAR 1	0.9081	0.8112	0.7134	0.5085	0.3940	0.3218	0.2324	0.1562
	719	718	717	714	711	708	702	696
YEAR 2	0.9251	0.8453	0.7723	0.6099	0.5281	0.4593	0.3382	0.3374
	717	716	715	712	709	706	700	694
YEAR 3	0.9092	0.7989	0.6807	0.3822	0.1836	0.1021	0.1768	0.2247
	717	716	715	712	709	70[illegible]	700	694
YEAR 4	0.9168	0.8344	0.7486	0.5116	0.3531	0.2728	0.2879	0.2932
	696	694	692	686	680	674	662	652
FISHZ	0.9150	0.8232	0.7305	0.5074	0.3713	0.2944	0.2594	0.2535
LINEAR REG	0.8564	0.7979	0.7417	0.5956	0.4783	0.3841	0.2477	0.1598

TOT NUM OBS 1HR COR 2849

DECEMBER

	HR 1	HR 2	HR 3	HR 6	HR 9	HR 12	HR 18	HR 24
OVERALL	0.9251	0.8439	0.7670	0.5894	0.4561	0.3606	0.2859	0.2653
YEAR 1	0.9331	0.8646	0.7877	0.6075	0.5076	0.4597	0.4935	0.4739
	576	574	572	566	560	554	542	530
YEAR 2	0.9277	0.8500	0.7770	0.6173	0.5328	0.4614	0.3370	0.3420
	693	692	691	688	685	682	676	670
YEAR 3	0.9253	0.8349	0.7587	0.6143	0.4794	0.3750	0.2608	0.2285
	743	742	741	738	735	732	726	720
YEAR 4	0.8990	0.8002	0.7042	0.4385	0.2618	0.1167	0.0161	0.0248
	740	738	737	734	731	728	722	716
FISHZ	0.9214	0.8371	0.7564	0.5708	0.4458	0.3537	0.2696	0.2584
LINEAR REG	0.8785	0.8199	0.7653	0.6222	0.5058	0.4112	0.2718	0.1797

TOT NUM OBS 1HR COR 2752

APPENDIX H

YPENBURG CROSS CORRELATIONS

JANUARY CORRELATION COEFFICIENTS / PROB > |R| UNDER H0:RHO=0 / NUMBER OF OBSERVATIONS

	ATT	EXT	CLOUD	W10M	W2M	TEMP	HUMID	DEWPT	AIR3TO5	EIR3TO5	AIR8TO12	EIR8TO12
ATT	1.00000	0.93146	0.07151	-0.36446	-0.41758	-0.09219	-0.62813	0.26996	-0.47898	0.44491	-0.35068	0.34556
	0.0000	0.0001	0.0194	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
	2905	2869	1068	1897	2905	2905	2905	2905	2806	2806	2823	2823
EXT	0.93146	1.00000	0.07335	-0.39206	-0.42624	-0.12939	-0.68999	0.28000	-0.60644	0.57326	-0.48037	0.47528
	0.0001	0.0000	0.0175	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
	2869	2869	1049	1869	2869	2869	2869	2869	2778	2778	2795	2795
CLOUD	0.07151	0.07335	1.00000	0.02176	0.02509	0.08408	-0.09422	0.13167	-0.02150	0.01124	-0.02423	-0.00323
	0.0194	0.0175	0.0000	0.5591	0.4128	0.0060	0.0021	0.0001	0.4905	0.7184	0.4353	0.9172
	1068	1049	1098	723	1068	1068	1068	1068	1031	1031	1039	1039
W10M	-0.36446	-0.39206	0.02176	1.00000	0.59119	0.06779	0.33843	-0.16990	0.17199	-0.16121	0.12026	-0.11804
	0.0001	0.0001	0.5591	0.0000	0.0001	0.0031	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
	1897	1869	723	1908	1897	1897	1897	1897	1815	1815	1826	1826
W2M	-0.41758	-0.42624	0.02509	0.59119	1.00000	0.06222	0.33893	-0.15244	0.11136	-0.09949	0.03894	-0.05333
	0.0001	0.0001	0.4128	0.0001	0.0000	0.0068	0.0001	0.0001	0.0001	0.0001	0.0386	0.0046
	2905	2869	1068	1897	2905	2905	2905	2905	2806	2806	2823	2823
TEMP	-0.09219	-0.12939	0.08408	0.06779	0.06222	1.00000	0.11611	0.80710	0.18859	-0.18856	0.21119	-0.18941
	0.0001	0.0001	0.0060	0.0031	0.0008	0.0000	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
	2905	2869	1068	1897	2905	2905	2905	2905	2806	2806	2823	2823
HUMID	-0.62813	-0.68999	-0.09422	0.33843	0.33893	0.11611	1.00000	-0.44920	0.48733	-0.46445	0.34401	-0.33140
	0.0001	0.0001	0.0021	0.0001	0.0001	0.0001	0.0000	0.0001	0.0001	0.0001	0.0001	0.0001
	2905	2869	1068	1897	2905	2905	2905	2905	2806	2806	2823	2823
DEWPT	0.26996	0.28000	0.13167	-0.16990	-0.15244	0.80710	-0.44920	1.00000	-0.07299	0.06285	0.02607	-0.01172
	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0000	0.0001	0.0009	0.1661	0.5336
	2905	2869	1068	1897	2905	2905	2905	2905	2806	2806	2823	2823
AIR3TO5	-0.47898	-0.60644	-0.02150	0.17199	0.11136	0.18859	0.48733	-0.07299	1.00000	-0.97827	0.82218	-0.80508
	0.0001	0.0001	0.4905	0.0001	0.0001	0.0001	0.0001	0.0001	0.0000	0.0001	0.0001	0.0001
	2806	2778	1031	1815	2806	2806	2806	2806	2806	2806	2804	2804
EIR3TO5	0.44491	0.57326	0.01124	-0.16121	-0.09949	-0.18856	-0.46445	0.06285	-0.97827	1.00000	-0.80070	0.80265
	0.0001	0.0001	0.7184	0.0001	0.0001	0.0001	0.0001	0.0009	0.0001	0.0000	0.0001	0.0001
	2806	2778	1031	1815	2806	2806	2806	2806	2806	2806	2804	2804
AIR8TO12	-0.35068	-0.48037	-0.02423	0.12026	0.03894	0.21119	0.34401	0.02607	0.82218	-0.80070	1.00000	-0.96933
	0.0001	0.0001	0.4353	0.0001	0.0386	0.0001	0.0001	0.1661	0.0001	0.0001	0.0000	0.0001
	2823	2795	1039	1826	2823	2823	2823	2823	2804	2804	2823	2823
EIR8TO12	0.34556	0.47528	-0.00323	-0.11804	-0.05333	-0.18941	-0.33140	-0.01172	-0.80508	0.80265	-0.96933	1.00000
	0.0001	0.0001	0.9172	0.0001	0.0046	0.0001	0.0001	0.5336	0.0001	0.0001	0.0001	0.0000
	2823	2795	1039	1826	2823	2823	2823	2823	2804	2804	2823	2823

FEBRUARY CORRELATION COEFFICIENTS / PROB > |R| UNDER H0:RHO=0 / NUMBER OF OBSERVATIONS

	ATT	EXT	CLOUD	W10M	W2M	TEMP	HUMID	DEWPT	AIR3TO5	EIR3TO5	AIR8TO12	EIR8TO12
ATT	1.00000 0.0000 2596	0.95414 0.0001 2541	0.06828 0.0202 1157	-0.48821 0.0001 2395	-0.39591 0.0001 2596	-0.24928 0.0001 2596	-0.55186 0.0001 2596	0.02242 0.2535 2596	-0.56317 0.0001 2515	0.55735 0.0001 2515	-0.47182 0.0001 2539	0.48535 0.0001 2539
EXT	0.95414 0.0001 2541	1.00000 0.0000 2541	0.10957 0.0002 1130	-0.48534 0.0001 2342	-0.39037 0.0001 2541	-0.22431 0.0001 2541	-0.61524 0.0001 2541	0.08219 0.0001 2541	-0.64263 0.0001 2464	0.63651 0.0001 2464	-0.51952 0.0001 2488	0.53376 0.0001 2488
CLOUD	0.06828 0.0202 1157	0.10957 0.0002 1130	1.00000 0.0000 1215	-0.02504 0.3975 1144	-0.06345 0.0309 1157	0.06029 0.0403 1157	-0.29518 0.0001 1157	0.23457 0.0001 1157	-0.08187 0.0062 1118	0.08642 0.0038 1118	-0.06101 0.0400 1134	0.05407 0.0688 1134
W10M	-0.48821 0.0001 2395	-0.48534 0.0001 2342	-0.02504 0.3975 1144	1.00000 0.0000 2447	0.65508 0.0001 2395	0.20602 0.0001 2395	0.31142 0.0001 2395	0.04302 0.0353 2395	0.16951 0.0001 2317	-0.15337 0.0001 2317	0.03714 0.0725 2339	-0.03850 0.0627 2339
W2M	-0.39591 0.0001 2596	-0.39037 0.0001 2541	-0.06345 0.0309 1157	0.65508 0.0001 2395	1.00000 0.0000 2596	0.20227 0.0001 2596	0.28571 0.0001 2596	0.01847 0.3469 2596	0.11491 0.0001 2515	-0.10933 0.0001 2515	0.05810 0.0034 2539	-0.06154 0.0019 2539
TEMP	-0.24928 0.0001 2596	-0.22431 0.0001 2541	0.06029 0.0403 1157	0.20602 0.0001 2395	0.20227 0.0001 2596	1.00000 0.0000 2596	0.12164 0.0001 2596	0.84696 0.0001 2596	0.23959 0.0001 2515	-0.29062 0.0001 2515	0.18546 0.0001 2539	-0.23456 0.0001 2539
HUMID	-0.55186 0.0001 2596	-0.61524 0.0001 2541	-0.29518 0.0001 1157	0.31142 0.0001 2395	0.28571 0.0001 2596	0.12164 0.0001 2596	1.00000 0.0000 2596	-0.37856 0.0001 2596	0.52597 0.0001 2515	-0.51323 0.0001 2515	0.33651 0.0001 2539	-0.31699 0.0001 2539
DEWPT	0.02242 0.2535 2596	0.08219 0.0001 2541	0.23457 0.0001 1157	0.04302 0.0353 2395	0.01847 0.3469 2596	0.84696 0.0001 2596	-0.37856 0.0001 2596	1.00000 0.0000 2596	-0.00325 0.8706 2515	-0.04679 0.0189 2515	0.04119 0.0380 2539	-0.09471 0.0001 2539
AIR3TO5	-0.56317 0.0001 2515	-0.64263 0.0001 2464	-0.08187 0.0062 1118	0.16951 0.0001 2317	0.11491 0.0001 2515	0.23959 0.0001 2515	0.52597 0.0001 2515	-0.00325 0.8706 2515	1.00000 0.0000 2515	-0.97370 0.0001 2515	0.77254 0.0001 2511	-0.74371 0.0001 2511
EIR3TO5	0.55735 0.0001 2515	0.63651 0.0001 2464	0.08642 0.0038 1118	-0.15337 0.0001 2317	-0.10933 0.0001 2515	-0.29062 0.0001 2515	-0.51323 0.0001 2515	-0.04679 0.0189 2515	-0.97370 0.0001 2515	1.00000 0.0000 2515	-0.73176 0.0001 2511	0.72607 0.0001 2511
AIR8TO12	-0.47182 0.0001 2539	-0.51952 0.0001 2488	-0.06101 0.0400 1134	0.03714 0.0725 2339	0.05810 0.0034 2539	0.18546 0.0001 2539	0.33651 0.0001 2539	0.04119 0.0380 2539	0.77254 0.0001 2511	-0.73176 0.0001 2511	1.00000 0.0000 2539	-0.96741 0.0001 2539
EIR8TO12	0.48535 0.0001 2539	0.53376 0.0001 2488	0.05407 0.0688 1134	-0.03850 0.0627 2339	-0.06154 0.0019 2539	-0.23456 0.0001 2539	-0.31699 0.0001 2539	-0.09471 0.0001 2539	-0.74371 0.0001 2511	0.72607 0.0001 2511	-0.96741 0.0001 2539	1.00000 0.0000 2539

MARCH CORRELATION COEFFICIENTS / PROB > |R| UNDER H0:/ NUMBER OF OBSERVATIONS

	ATT	EXT	CLOUD	W10M	W2M	TEMP	HUMID	DEWPT	AIR3TO5	EIR3TO5	AIR8TO12	EIR8TO12
ATT	1.00000	0.93954	0.06367	-0.24742	-0.38199	-0.07154	-0.46694	0.19732	-0.45047	0.44574	-0.28634	0.29508
	0.0000	0.0001	0.1370	0.0001	0.0001	0.0002	0.0061	0.0001	0.0001	0.0001	0.0001	0.0001
	2654	2400	547	2183	2653	2652	2649	2649	2556	2556	2553	2553
EXT	0.93954	1.00000	0.06642	-0.24899	-0.36989	-0.09728	-0.50376	0.17752	-0.56344	0.56623	-0.35869	0.38415
	0.0001	0.0000	0.1289	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
	2400	2586	524	2163	2585	2584	2581	2581	2531	2531	2523	2523
CLOUD	0.06367	0.06642	1.00000	0.08149	-0.06833	0.18122	-0.11205	0.25494	0.07641	-0.08867	-0.05624	0.07523
	0.1370	0.1289	0.0000	0.0662	0.1023	0.0001	0.0073	0.0001	0.0726	0.0371	0.1866	0.0771
	547	524	610	509	573	573	572	572	553	553	553	553
W10M	-0.24742	-0.24899	0.08149	1.00000	0.67884	0.28831	0.06285	0.22872	0.02029	-0.02957	-0.13850	0.12650
	0.0001	0.0001	0.0662	0.0000	0.0001	0.0001	0.0022	0.0001	0.3306	0.1561	0.0001	0.0001
	2183	2163	509	2380	2370	2369	2366	2366	2302	2302	2290	2290
W2M	-0.38199	-0.36989	-0.06833	0.67884	1.00000	0.15866	0.14755	0.06885	0.06662	-0.07187	-0.00690	0.00513
	0.0001	0.0001	0.1023	0.0001	0.0000	0.0001	0.0001	0.0002	0.0005	0.0002	0.7186	0.7884
	2653	2585	573	2370	2840	2839	2836	2836	2742	2742	2734	2734
TEMP	-0.07154	-0.09728	0.18122	0.28831	0.15866	1.00000	0.16378	0.78424	0.19147	-0.20203	0.06787	-0.03231
	0.0002	0.0001	0.0001	0.0001	0.0001	0.0000	0.0001	0.0001	0.0001	0.0001	0.0004	0.0912
	2652	2584	573	2369	2839	2839	2836	2836	2741	2741	2733	2733
HUMID	-0.46694	-0.50376	-0.11205	0.06285	0.14755	0.16378	1.00000	-0.42545	0.43013	-0.43106	0.34681	-0.37237
	0.0001	0.0001	0.0073	0.0022	0.0001	0.0001	0.0000	0.0001	0.0001	0.0001	0.0001	0.0001
	2649	2581	572	2366	2836	2836	2836	2836	2741	2741	2733	2733
DEWPT	0.19732	0.17752	0.25494	0.22872	0.06885	0.78424	-0.42545	1.00000	-0.07296	0.06038	-0.10487	0.14906
	0.0001	0.0001	0.0001	0.0001	0.0002	0.0001	0.0001	0.0000	0.0001	0.0016	0.0001	0.0001
	2649	2581	572	2366	2836	2836	2836	2836	2741	2741	2733	2733
AIR3TO5	-0.45047	-0.56344	0.07641	0.02029	0.06662	0.19147	0.43013	-0.07296	1.00000	-0.97656	0.52410	-0.54690
	0.0001	0.0001	0.0726	0.3306	0.0005	0.0001	0.0001	0.0001	0.0000	0.0001	0.0001	0.0001
	2556	2531	553	2302	2742	2741	2741	2741	2745	2745	2728	2728
EIR3TO5	0.44574	0.56623	-0.08867	-0.02957	-0.07187	-0.20203	-0.43106	0.06038	-0.97656	1.00000	-0.50828	0.54451
	0.0001	0.0001	0.0371	0.1561	0.0002	0.0001	0.0001	0.0016	0.0001	0.0000	0.0001	0.0001
	2556	2531	553	2302	2742	2741	2741	2741	2745	2745	2728	2728
AIR8TO12	-0.28634	-0.35869	-0.05624	-0.13850	-0.00690	0.06787	0.34681	-0.10487	0.52410	-0.50828	1.00000	-0.93987
	0.0001	0.0001	0.1866	0.0001	0.7186	0.0004	0.0001	0.0001	0.0001	0.0001	0.0000	0.0001
	2553	2523	553	2290	2734	2733	2733	2733	2728	2728	2737	2737
EIR8TO12	0.29508	0.38415	0.07523	0.12650	0.00513	-0.03231	-0.37237	0.14906	-0.54690	0.54451	-0.93987	1.00000
	0.0001	0.0001	0.0771	0.0001	0.7884	0.0912	0.0001	0.0001	0.0001	0.0001	0.0001	0.0000
	2553	2523	553	2290	2734	2733	2733	2733	2728	2728	2737	2737

APRIL CORRELATION COEFFICIENTS / PROB > |R| UNDER H0:/ NUMBER OF OBSERVATIONS

	ATT	EXT	CLOUD	W10M	W2M	TEMP	HUMID	DEWPT	AIR3TO5	EIR3TO5	AIR8TO12	EIR8TO12
ATT	1.00000 0.0000 2725	0.89804 0.0001 2377	-0.00246 0.9376 1014	-0.20358 0.0001 2610	-0.29393 0.0001 2725	0.14937 0.0001 2725	-0.42336 0.0001 2724	0.38882 0.0001 2724	-0.22566 0.0001 2356	0.22859 0.0001 2356	-0.28468 0.0001 2354	0.28835 0.0001 2354
EXT	0.89804 0.0001 2377	1.00000 0.0000 2377	-0.00200 0.9526 883	-0.26653 0.0001 2281	-0.29059 0.0001 2377	0.02640 0.1982 2377	-0.46976 0.0001 2376	0.29652 0.0001 2376	-0.35467 0.0001 2351	0.34934 0.0001 2351	-0.33288 0.0001 2349	0.33938 0.0001 2349
CLOUD	-0.00246 0.9376 1014	-0.00200 0.9526 883	1.00000 0.0000 1069	0.11381 0.0003 1005	0.05096 0.1048 1014	-0.13061 0.0001 1014	-0.21668 0.0001 1013	0.07868 0.0122 1013	-0.01280 0.7064 869	0.00009 0.9980 869	0.09578 0.0047 868	-0.07834 0.0210 868
W10M	-0.20358 0.0001 2610	-0.26653 0.0001 2281	0.11381 0.0003 1005	1.00000 0.0000 2611	0.62982 0.0001 2610	0.18609 0.0001 2610	0.00856 0.6620 2609	0.23313 0.0001 2609	-0.02840 0.1771 2260	0.04746 0.0241 2260	0.06511 0.0020 2258	-0.06461 0.0021 2258
W2M	-0.29393 0.0001 2725	-0.29059 0.0001 2377	0.05096 0.1048 1014	0.62982 0.0001 2610	1.00000 0.0000 2725	0.02839 0.1384 2725	0.08044 0.0001 2724	0.03628 0.0583 2724	-0.11284 0.0001 2356	0.12998 0.0001 2356	0.00908 0.6598 2354	-0.00660 0.7488 2354
TEMP	0.14937 0.0001 2725	0.02640 0.1982 2377	-0.13061 0.0001 1014	0.18609 0.0001 2610	0.02839 0.1384 2725	1.00000 0.0000 2725	0.30589 0.0001 2724	0.71048 0.0001 2724	0.16196 0.0001 2356	-0.15148 0.0001 2356	0.15927 0.0001 2354	-0.15719 0.0001 2354
HUMID	-0.42336 0.0001 2724	-0.46976 0.0001 2376	-0.21668 0.0001 1013	0.00856 0.6620 2609	0.08044 0.0001 2724	0.30589 0.0001 2724	1.00000 0.0000 2724	-0.37188 0.0001 2724	0.37059 0.0001 2356	-0.34447 0.0001 2356	0.25433 0.0001 2354	-0.25114 0.0001 2354
DEWPT	0.38882 0.0001 2724	0.29652 0.0001 2376	0.07868 0.0122 1013	0.23313 0.0001 2609	0.03628 0.0583 2724	0.71048 0.0001 2724	-0.37188 0.0001 2724	1.00000 0.0000 2724	-0.05008 0.0151 2356	0.04649 0.0240 2356	0.03147 0.1269 2354	-0.03022 0.1427 2354
AIR3TO5	-0.22566 0.0001 2356	-0.35467 0.0001 2351	-0.01280 0.7064 869	-0.02840 0.1771 2260	-0.11284 0.0001 2356	0.16196 0.0001 2356	0.37059 0.0001 2356	-0.05008 0.0151 2356	1.00000 0.0000 2356	-0.98127 0.0001 2356	0.56115 0.0001 2350	-0.55774 0.0001 2350
EIR3TO5	0.22859 0.0001 2356	0.34934 0.0001 2351	0.00009 0.9980 869	0.04746 0.0241 2260	0.12998 0.0001 2356	-0.15148 0.0001 2356	-0.34447 0.0001 2356	0.04649 0.0240 2356	-0.98127 0.0001 2356	1.00000 0.0000 2356	-0.55308 0.0001 2350	0.56027 0.0001 2350
AIR8TO12	-0.28468 0.0001 2354	-0.33288 0.0001 2349	0.09578 0.0047 868	0.06511 0.0020 2258	0.00908 0.6598 2354	0.15927 0.0001 2354	0.25433 0.0001 2354	0.03147 0.1269 2354	-0.56115 0.0001 2350	-0.55308 0.0001 2350	1.00000 0.0000 2354	-0.96224 0.0001 2354
EIR8TO12	0.28835 0.0001 2354	0.33938 0.0001 2349	-0.07834 0.0210 868	-0.06461 0.0021 2258	-0.00660 0.7488 2354	-0.15719 0.0001 2354	-0.25114 0.0001 2354	-0.03022 0.1427 2354	-0.55774 0.0001 2350	0.56027 0.0001 2350	-0.96224 0.0001 2354	1.00000 0.0000 2354

MAY CORRELATION COEFFICIENTS / PROB > |R| UNDER H0:RHO=0 / NUMBER OF OBSERVATIONS

	ATT	EXT	CLOUD	W10M	W2M	TEMP	HUMID	DEWPT	AIR3TO5	EIR3TO5	AIR8TO12	EIR8TO12
ATT	1.00000 0.0000 2766	0.89314 0.0001 2582	0.07564 0.2564 227	-0.30960 0.0001 2470	-0.14691 0.0001 2766	0.08566 0.0001 2766	-0.52922 0.0001 2764	0.46860 0.0001 2764	-0.27089 0.0001 1985	0.26698 0.0001 1985	-0.27027 0.0001 1986	0.26795 0.0001 1986
EXT	0.89314 0.0001 2582	1.00000 0.0000 2582	-0.11572 0.0913 214	-0.37954 0.0001 2286	-0.13241 0.0001 2582	0.10088 0.0001 2582	-0.54037 0.0001 2580	0.47249 0.0001 2580	-0.38789 0.0001 1873	0.39200 0.0001 1873	-0.33459 0.0001 1875	0.35046 0.0001 1875
CLOUD	0.07564 0.2564 227	-0.11572 0.0913 214	1.00000 0.0000 244	0.04065 0.5608 207	-0.10548 0.1130 227	-0.13699 0.0392 227	-0.21901 0.0009 227	0.05486 0.4107 227	0.22012 0.0045 165	-0.21866 0.0049 165	0.10411 0.1860 163	-0.03327 0.6733 163
W10M	-0.30960 0.0001 2470	-0.37954 0.0001 2286	0.04065 0.5608 207	1.00000 0.0000 2472	0.25425 0.0001 2470	0.02286 0.2561 2470	0.19848 0.0001 2468	-0.12530 0.0001 2468	0.10227 0.0001 1784	-0.09628 0.0001 1784	0.06621 0.0051 1785	-0.06107 0.0099 1785
W2M	-0.14691 0.0001 2766	-0.13241 0.0001 2582	-0.10548 0.1130 227	0.25425 0.0001 2470	1.00000 0.0000 2766	-0.12984 0.0001 2766	0.02541 0.1817 2764	-0.08550 0.0001 2764	0.00643 0.7746 1985	-0.03066 0.1721 1985	-0.01853 0.4092 1986	-0.00296 0.8953 1986
TEMP	0.08566 0.0001 2766	0.10088 0.0001 2582	-0.13699 0.0392 227	0.02286 0.2561 2470	-0.12984 0.0001 2766	1.00000 0.0000 2766	0.33252 0.0001 2764	0.68203 0.0001 2764	0.02283 0.3092 1985	0.00205 0.9274 1985	0.05818 0.0095 1986	-0.03804 0.0902 1986
HUMID	-0.52922 0.0001 2764	-0.54037 0.0001 2580	-0.21901 0.0009 227	0.19848 0.0001 2468	0.02541 0.1817 2764	0.33252 0.0001 2764	1.00000 0.0000 2764	-0.35824 0.0001 2764	0.25603 0.0001 1985	-0.25106 0.0001 1985	0.29513 0.0001 1986	-0.29508 0.0001 1986
DEWPT	0.46860 0.0001 2764	0.47249 0.0001 2580	0.05486 0.4107 227	-0.12530 0.0001 2468	-0.08550 0.0001 2764	0.68203 0.0001 2764	-0.35824 0.0001 2764	1.00000 0.0000 2764	-0.09777 0.0001 1985	0.10989 0.0001 1985	-0.07661 0.0006 1986	0.08278 0.0002 1986
AIR3TO5	-0.27089 0.0001 1985	-0.38789 0.0001 1873	0.22012 0.0045 165	0.10227 0.0001 1784	0.00643 0.7746 1985	0.02283 0.3092 1985	0.25603 0.0001 1985	-0.09777 0.0001 1985	1.00000 0.0000 1985	-0.95023 0.0001 1985	0.64596 0.0001 1986	-0.65412 0.0001 1980
EIR3TO5	0.26698 0.0001 1985	0.39200 0.0001 1873	-0.21866 0.0049 165	-0.09628 0.0001 1784	-0.03066 0.1721 1985	0.00205 0.9274 1985	-0.25106 0.0001 1985	0.10989 0.0001 1985	-0.95023 0.0001 1985	1.00000 0.0000 1985	-0.63549 0.0001 1980	0.66100 0.0001 1980
AIR8TO12	-0.27027 0.0001 1986	-0.33459 0.0001 1875	0.10411 0.1860 163	0.06621 0.0051 1785	-0.01853 0.4092 1986	0.05818 0.0095 1986	0.29513 0.0001 1986	-0.07661 0.0006 1986	0.64596 0.0001 1980	-0.63549 0.0001 1980	1.00000 0.0000 1986	-0.93918 0.0001 1986
EIR8TO12	0.26795 0.0001 1986	0.35046 0.0001 1875	-0.03327 0.6733 163	-0.06107 0.0099 1785	-0.00296 0.8953 1986	-0.03804 0.0902 1986	-0.29508 0.0001 1986	0.08278 0.0002 1986	-0.65412 0.0001 1980	0.66100 0.0001 1980	-0.93918 0.0001 1986	1.00000 0.0000 1986

JUNE CORRELATION COEFFICIENTS / PROB > |R| UNDER H0:RHO=0 / NUMBER OF OBSERVATIONS

	ATT	EXT	CLOUD	W10M	W2M	TEMP	HUMID	DEWPT	AIR3TO5	EIR3TO5	AIR8TO12	EIR8TO12
ATT	1.00000 0.0000 1775	0.81195 0.0001 1658	0	-0.14852 0.0001 1580	-0.22333 0.0001 1550	0.16134 0.0001 1772	-0.37333 0.0001 1729	0.52229 0.0001 1729	-0.26988 0.0001 1613	0.26078 0.0001 1613	-0.14128 0.0001 1613	0.14888 0.0001 1613
EXT	0.81195 0.0001 1658	1.00000 0.0000 1658	0	-0.18547 0.0001 1464	-0.18071 0.0001 1444	0.13282 0.0001 1655	-0.44438 0.0001 1632	0.51035 0.0001 1632	-0.35620 0.0001 1555	0.34866 0.0001 1555	-0.26611 0.0001 1555	0.27988 0.0001 1555
CLOUD	0	0	0	0	0	0	0	0	0	0	0	0
W10M	-0.14852 0.0001 1580	-0.18547 0.0001 1464	0	1.00000 0.0000 1653	0.32865 0.0001 1390	-0.06004 0.0171 1578	-0.01355 0.5957 1535	-0.00725 0.7766 1535	-0.01393 0.5997 1423	0.00743 0.7795 1423	-0.01159 0.6621 1423	0.00873 0.7421 1423
W2M	-0.22333 0.0001 1550	-0.18071 0.0001 1444	0	0.32865 0.0001 1390	1.00000 0.0000 1550	-0.17066 0.0001 1548	0.06287 0.0146 1507	-0.20695 0.0001 1507	-0.01556 0.5597 1407	0.02571 0.3352 1407	-0.12363 0.0001 1406	0.12087 0.0001 1406
TEMP	0.16134 0.0001 1772	0.13282 0.0001 1655	0	-0.06004 0.0171 1578	-0.17066 0.0001 1548	1.00000 0.0000 1772	0.43054 0.0001 1729	0.57782 0.0001 1729	0.02055 0.4097 1612	-0.00667 0.7890 1612	0.14854 0.0001 1612	-0.12481 0.0001 1612
HUMID	-0.37333 0.0001 1729	-0.44438 0.0001 1632	0	-0.01355 0.5957 1535	0.06287 0.0146 1507	0.43054 0.0001 1729	1.00000 0.0000 1729	-0.36769 0.0001 1729	0.25378 0.0001 1599	-0.22173 0.0001 1599	0.25303 0.0001 1599	-0.23951 0.0001 1599
DEWPT	0.52229 0.0001 1729	0.51035 0.0001 1632	0	-0.00725 0.7766 1535	-0.20695 0.0001 1507	0.57782 0.0001 1729	-0.36769 0.0001 1729	1.00000 0.0000 1729	-0.16359 0.0001 1599	0.14646 0.0001 1599	-0.03409 0.1730 1599	0.03487 0.1635 1599
AIR3TO5	-0.26988 0.0001 1613	-0.35620 0.0001 1555	0	-0.01393 0.5997 1423	-0.01556 0.5597 1407	0.02055 0.4097 1612	0.25378 0.0001 1599	-0.16359 0.0001 1599	1.00000 0.0000 1721	-0.97610 0.0001 1721	0.63158 0.0001 1720	-0.64214 0.0001 1720
EIR3TO5	0.26078 0.0001 1613	0.34866 0.0001 1555	0	0.00743 0.7795 1423	0.02571 0.3352 1407	-0.00667 0.7890 1612	-0.22173 0.0001 1599	0.14646 0.0001 1599	-0.97610 0.0001 1721	1.00000 0.0000 1721	-0.60939 0.0001 1720	0.62884 0.0001 1720
AIR8TO12	-0.14128 0.0001 1613	-0.26611 0.0001 1555	0	-0.01159 0.6621 1423	-0.12363 0.0001 1406	0.14854 0.0001 1612	0.25303 0.0001 1599	-0.03409 0.1730 1599	0.63158 0.0001 1720	-0.60939 0.0001 1720	1.00000 0.0000 1721	-0.94287 0.0001 1721
EIR8TO12	0.14888 0.0001 1613	0.27988 0.0001 1555	0	0.00873 0.7421 1423	0.12087 0.0001 1406	-0.12481 0.0001 1612	-0.23951 0.0001 1599	0.03487 0.1635 1599	-0.64214 0.0001 1720	0.62884 0.0001 1720	-0.94287 0.0001 1721	1.00000 0.0000 1721

JULY CORRELATION COEFFICIENTS / PROB > |R| UNDER H0:RHO=0 / NUMBER OF OBSERVATIONS

	ATT	EXT	CLOUD	W10M	W2M	TEMP	HUMID	DEWPT	AIR3TO5	EIR3TO5	AIR8TO12	EIR8TO12
ATT	1.00000 0.0000 2831	0.87623 0.0001 2278	-0.02306 0.4573 1041	-0.20133 0.0001 2545	-0.27763 0.0001 2831	0.26366 0.0001 2831	-0.36898 0.0001 2748	0.50529 0.0001 2748	-0.39617 0.0001 2695	0.39654 0.0001 2695	-0.24936 0.0001 2695	0.24934 0.0001 2695
EXT	0.87623 0.0001 2278	1.00000 0.0000 2291	-0.08047 0.0197 840	-0.19158 0.0001 2026	-0.18603 0.0001 2291	0.20813 0.0001 2291	-0.51507 0.0001 2228	0.56491 0.0001 2228	-0.48793 0.0001 2181	0.48693 0.0001 2181	-0.38710 0.0001 2181	0.40692 0.0001 2181
CLOUD	-0.02306 0.4573 1041	-0.08047 0.0197 849	1.00000 0.0000 1101	0.13034 0.0001 1003	0.06688 0.0305 1047	-0.27703 0.0001 1047	-0.30914 0.0001 1033	0.00355 0.9093 1033	-0.09871 0.0017 1012	0.07137 0.0232 1012	-0.11093 0.0004 1012	0.10931 0.0005 1012
W10M	-0.20133 0.0001 2545	-0.19158 0.0001 2026	0.13034 0.0001 1003	1.00000 0.0000 2634	0.38618 0.0001 2558	0.06350 0.0013 2558	0.00164 0.9349 2476	0.05875 0.0035 2476	0.04579 0.0242 2423	-0.03655 0.0721 2423	0.08519 0.0001 2423	-0.06705 0.0010 2423
W2M	-0.27763 0.0001 2831	-0.18603 0.0001 2291	0.06688 0.0305 1047	0.38618 0.0001 2558	1.00000 0.0000 2844	-0.17626 0.0001 2844	0.03832 0.0441 2761	-0.18205 0.0001 2761	0.02505 0.1925 2708	-0.00443 0.8178 2708	-0.02272 0.2372 2708	0.04405 0.0219 2708
TEMP	0.26366 0.0001 2831	0.20813 0.0001 2291	-0.27703 0.0001 1047	0.06350 0.0013 2558	-0.17626 0.0001 2844	1.00000 0.0000 2844	0.31237 0.0001 2761	0.72329 0.0001 2761	0.05939 0.0020 2708	-0.03966 0.0390 2708	0.22630 0.0001 2708	-0.20923 0.0001 2708
HUMID	-0.36898 0.0001 2748	-0.51507 0.0001 2228	-0.30914 0.0001 1033	0.00164 0.9349 2476	0.03832 0.0441 2761	0.31287 0.0001 2761	1.00000 0.0000 2761	-0.36802 0.0001 2761	0.35865 0.0001 2708	-0.32425 0.0001 2708	0.35179 0.0001 2708	-0.33836 0.0001 2708
DEWPT	0.50529 0.0001 2748	0.56491 0.0001 2228	0.00355 0.9093 1033	0.05875 0.0035 2476	-0.18205 0.0001 2761	0.72329 0.0001 2761	-0.36802 0.0001 2761	1.00000 0.0000 2761	-0.14965 0.0001 2708	0.14827 0.0001 2708	0.00529 0.7831 2708	-0.00162 0.9328 2708
AIR3TO5	-0.39617 0.0001 2695	-0.48793 0.0001 2181	-0.09871 0.0017 1012	0.04579 0.0242 2423	0.02505 0.1925 2708	0.05939 0.0020 2708	0.35865 0.0001 2708	-0.14965 0.0001 2708	1.00000 0.0000 2708	-0.97548 0.0001 2708	0.66260 0.0001 2708	-0.66611 0.0001 2708
EIR3TO5	0.39654 0.0001 2695	0.48693 0.0001 2181	0.07137 0.0232 1012	-0.03655 0.0721 2423	-0.00443 0.8178 2708	-0.03966 0.0390 2708	-0.32425 0.0001 2708	0.14827 0.0001 2708	-0.97548 0.0001 2708	1.00000 0.0000 2708	-0.64602 0.0001 2708	0.66269 0.0001 2708
AIR8TO12	-0.24936 0.0001 2695	-0.38710 0.0001 2181	-0.11093 0.0004 1012	0.08519 0.0001 2423	-0.02272 0.2372 2708	0.22630 0.0001 2708	0.35179 0.0001 2708	0.00529 0.7831 2708	0.66260 0.0001 2708	-0.64602 0.0001 2708	1.00000 0.0000 2708	-0.93835 0.0001 2708
EIR8TO12	0.24934 0.0001 2695	0.40692 0.0001 2181	0.10931 0.0005 1012	-0.06705 0.0010 2423	0.04405 0.0219 2708	-0.20923 0.0001 2708	-0.33836 0.0001 2708	-0.00162 0.9328 2708	-0.66611 0.0001 2708	0.66269 0.0001 2708	-0.93835 0.0001 2708	1.00000 0.0000 2708

AUGUST CORRELATION COEFFICIENTS / PROB > |R| UNDER H0:RHO=0 / NUMBER OF OBSERVATIONS

	ATT	EXT	CLOUD	W10M	W2M	TEMP	HUMID	DEWPT	AIR3TO5	EIR3TO5	AIR8TO12	EIR8TO12
ATT	1.00000 0.0000 2608	0.91161 0.0001 2507	0.06166 0.0551 968	-0.37764 0.0001 2516	-0.41871 0.0001 2608	0.04656 0.0174 2608	-0.43186 0.0001 2418	0.33045 0.0001 2418	-0.42120 0.0001 2335	0.41097 0.0001 2335	-0.24728 0.0001 2341	0.25712 0.0001 2341
EXT	0.91161 0.0001 2507	1.00000 0.0000 2529	0.00626 0.8474 946	-0.35379 0.0001 2441	-0.36941 0.0001 2529	0.04141 0.0373 2529	-0.43820 0.0001 2344	0.34763 0.0001 2344	-0.49422 0.0001 2285	0.48236 0.0001 2285	-0.37022 0.0001 2290	0.38726 0.0001 2290
CLOUD	0.06166 0.0551 968	0.00626 0.8474 946	1.00000 0.0000 1113	0.02600 0.4153 984	-0.07927 0.0133 975	-0.10260 0.0013 975	-0.27956 0.0001 930	0.16892 0.0001 930	-0.03193 0.3398 896	0.02134 0.5235 896	-0.08550 0.0103 899	0.08795 0.0083 899
W10M	-0.37764 0.0001 2516	-0.35379 0.0001 2441	0.02600 0.4153 984	1.00000 0.0000 2573	0.50286 0.0001 2538	0.15829 0.0001 2538	0.15225 0.0001 2353	0.11572 0.0001 2353	0.10741 0.0001 2270	-0.07478 0.0004 2270	0.09721 0.0001 2276	-0.08803 0.0001 2276
W2M	-0.41871 0.0001 2608	-0.36941 0.0001 2529	-0.07927 0.0133 975	0.50286 0.0001 2538	1.00000 0.0000 2630	-0.03045 0.1184 2630	0.20223 0.0001 2440	-0.14138 0.0001 2440	0.12993 0.0001 2357	-0.11111 0.0001 2357	0.01483 0.4711 2363	-0.00018 0.9930 2363
TEMP	0.04656 0.0174 2608	0.04141 0.0373 2529	-0.10260 0.0013 975	0.15829 0.0001 2538	-0.03045 0.1184 2630	1.00000 0.0000 2630	0.41449 0.0001 2440	0.70680 0.0001 2440	0.17852 0.0001 2357	-0.15621 0.0001 2357	0.36549 0.0001 2363	-0.34266 0.0001 2363
HUMID	-0.43185 0.0001 2418	-0.43820 0.0001 2344	-0.27956 0.0001 930	0.15225 0.0001 2353	0.20223 0.0001 2440	0.41449 0.0001 2440	1.00000 0.0000 2440	-0.28645 0.0001 2440	0.32424 0.0001 2357	-0.29863 0.0001 2357	0.30446 0.0001 2363	-0.28971 0.0001 2363
DEWPT	0.33045 0.0001 2418	0.34763 0.0001 2344	0.16892 0.0001 930	0.11572 0.0001 2353	-0.14138 0.0001 2440	0.70680 0.0001 2440	-0.28645 0.0001 2440	1.00000 0.0000 2440	0.02197 0.2864 2357	-0.01387 0.5008 2357	0.21102 0.0001 2363	-0.20222 0.0001 2363
AIR3TO5	-0.42120 0.0001 2335	-0.49422 0.0001 2285	-0.03193 0.3398 896	0.10741 0.0001 2270	0.12993 0.0001 2357	0.17852 0.0001 2357	0.32424 0.0001 2357	0.02197 0.2864 2357	1.00000 0.0000 2357	-0.97175 0.0001 2357	0.63622 0.0001 2357	-0.66244 0.0001 2357
EIR3TO5	0.41097 0.0001 2335	0.48236 0.0001 2285	0.02134 0.5235 896	-0.07478 0.0004 2270	-0.11111 0.0001 2357	-0.15621 0.0001 2357	-0.29863 0.0001 2357	-0.01387 0.5008 2357	-0.97175 0.0001 2357	1.00000 0.0000 2357	-0.61436 0.0001 2357	0.65281 0.0001 2357
AIR8TO12	-0.24728 0.0001 2341	-0.37022 0.0001 2290	-0.08550 0.0103 899	0.09721 0.0001 2276	0.01483 0.4711 2363	0.36549 0.0001 2363	0.30446 0.0001 2363	0.21102 0.0001 2363	0.63622 0.0001 2357	-0.61436 0.0001 2357	1.00000 0.0000 2363	-0.94399 0.0001 2363
EIR8TO12	0.25712 0.0001 2341	0.38726 0.0001 2290	0.08795 0.0083 899	-0.08803 0.0001 2276	-0.00018 0.9930 2363	-0.34266 0.0001 2363	-0.28971 0.0001 2363	-0.20222 0.0001 2363	-0.66244 0.0001 2357	0.65281 0.0001 2357	-0.94399 0.0001 2363	1.00000 0.0000 2363

SEPTEMBER CORRELATION COEFFICIENTS / PROB > |R| UNDER H0:RHO=0 / NUMBER OF OBSERVATIONS

	ATT	EXT	CLOUD	W10M	W2M	TEMP	HUMID	DEWPT	AIR3TO5	EIR3TO5	AIR8TO12	EIR8TO12
ATT	1.00000 0.0000 2483	0.85823 0.0001 1960	0.05280 0.1119 908	-0.30866 0.0001 2239	-0.34840 0.0001 2141	0.12273 0.0001 2112	-0.48542 0.0001 2085	0.35387 0.0001 2085	-0.45322 0.0001 1959	0.42738 0.0001 1959	-0.32195 0.0001 1957	0.30685 0.0001 1957
EXT	0.85823 0.0001 1960	1.00000 0.0000 2013	0.01954 0.5938 747	-0.27230 0.0001 1789	-0.34563 0.0001 1743	0.18311 0.0001 1714	-0.51623 0.0001 1696	0.41822 0.0001 1696	-0.58773 0.0001 1588	0.56308 0.0001 1588	-0.43266 0.0001 1588	0.43728 0.0001 1588
CLOUD	0.05280 0.1119 908	0.01954 0.5938 747	1.00000 0.0000 1063	0.08394 0.0126 883	0.05346 0.1296 805	0.02646 0.4563 795	-0.11700 0.0010 791	0.08389 0.0183 791	0.00203 0.9558 747	-0.00572 0.8759 747	0.03093 0.3989 746	-0.02317 0.5274 746
W10M	-0.30866 0.0001 2239	-0.27230 0.0001 1789	0.08394 0.0126 883	1.00000 0.0000 2317	0.50523 0.0001 2115	0.19836 0.0001 2086	0.14820 0.0001 2059	0.14036 0.0001 2059	0.08939 0.0001 1939	-0.06816 0.0027 1939	0.12989 0.0001 1937	-0.12267 0.0001 1937
W2M	-0.34840 0.0001 2141	-0.34563 0.0001 1743	0.05346 0.1296 805	0.50523 0.0001 2115	1.00000 0.0000 2194	0.04443 0.0388 2164	0.21680 0.0001 2137	-0.04423 0.0409 2137	0.10769 0.0001 2012	-0.07850 0.0004 2012	0.12394 0.0001 2010	-0.11507 0.0001 2010
TEMP	0.12273 0.0001 2112	0.18311 0.0001 1714	0.02646 0.4563 795	0.19836 0.0001 2086	0.04443 0.0388 2164	1.00000 0.0000 2165	0.13848 0.0001 2138	0.80057 0.0001 2138	0.09286 0.0001 2012	-0.07123 0.0014 2012	0.35365 0.0001 2010	-0.31565 0.0001 2010
HUMID	-0.48542 0.0001 2085	-0.51623 0.0001 1696	-0.11700 0.0010 791	0.14820 0.0001 2059	0.21680 0.0001 2137	0.13848 0.0001 2138	1.00000 0.0000 2138	-0.41642 0.0001 2138	0.44417 0.0001 2012	-0.41905 0.0001 2012	0.34870 0.0001 2010	-0.32725 0.0001 2010
DEWPT	0.35387 0.0001 2085	0.41822 0.0001 1696	0.08389 0.0183 791	0.14036 0.0001 2059	-0.04423 0.0409 2137	0.80057 0.0001 2138	-0.41642 0.0001 2138	1.00000 0.0000 2138	-0.12843 0.0001 2012	0.13888 0.0001 2012	0.15085 0.0001 2010	-0.13316 0.0001 2010
AIR3TO5	-0.45322 0.0001 1959	-0.58773 0.0001 1588	0.00203 0.9558 747	0.08939 0.0001 1939	0.10769 0.0001 2012	0.09286 0.0001 2012	0.44417 0.0001 2012	-0.12843 0.0001 2012	1.00000 0.0000 2012	-0.97466 0.0001 2012	0.68511 0.0001 2008	-0.67759 0.0001 2008
EIR3TO5	0.42738 0.0001 1959	0.56308 0.0001 1588	-0.00572 0.8759 747	-0.06816 0.0027 1939	-0.07850 0.0004 2012	-0.07123 0.0014 2012	-0.41905 0.0001 2012	0.13888 0.0001 2012	-0.97466 0.0001 2012	1.00000 0.0000 2012	-0.65577 0.0001 2008	0.65674 0.0001 2008
AIR8TO12	-0.32195 0.0001 1957	-0.43266 0.0001 1588	0.03093 0.3989 746	0.12989 0.0001 1937	0.12394 0.0001 2010	0.35365 0.0001 2010	0.34870 0.0001 2010	0.15085 0.0001 2010	0.68511 0.0001 2008	-0.65577 0.0001 2008	1.00000 0.0000 2010	-0.95235 0.0001 2010
EIR8TO12	0.30685 0.0001 1957	0.43728 0.0001 1588	-0.02317 0.5274 746	-0.12267 0.0001 1937	-0.11507 0.0001 2010	-0.31565 0.0001 2010	-0.32725 0.0001 2010	-0.13316 0.0001 2010	-0.67759 0.0001 2008	0.65674 0.0001 2008	-0.95235 0.0001 2010	1.00000 0.0000 2010

OCTOBER CORRELATION COEFFICIENTS / PROB > |R| UNDER H0:RHO=0 / NUMBER OF OBSERVATIONS

	ATT	EXT	CLOUD	W10M	W2M	TEMP	HUMID	DEWPT	AIR3TO5	EIR3TO5	AIR8TO12	EIR8TO12
ATT	1.00000 0.0000 2741	0.93945 0.0001 2641	0.16096 0.0001 1250	-0.44366 0.0001 2500	-0.42377 0.0001 2635	-0.10734 0.0001 2740	-0.58336 0.0001 2625	0.18359 0.0001 2625	-0.62115 0.0001 2490	0.65463 0.0001 2490	-0.37632 0.0001 2503	0.34235 0.0001 2503
EXT	0.93945 0.0001 2641	1.00000 0.0000 2642	0.09659 0.0008 1198	-0.48919 0.0001 2401	-0.42183 0.0001 2622	-0.09353 0.0001 2641	-0.63085 0.0001 2526	0.22649 0.0001 2526	-0.68803 0.0001 2411	0.73469 0.0001 2411	-0.44200 0.0001 2423	0.42099 0.0001 2423
CLOUD	0.16096 0.0001 1250	0.09659 0.0008 1198	1.00000 0.0000 1361	0.04545 0.1176 1187	0.00226 0.9374 1205	-0.01525 0.5902 1250	-0.27647 0.0001 1224	0.15866 0.0001 1224	-0.09652 0.0010 1167	0.11304 0.0001 1167	-0.09727 0.0009 1168	0.08166 0.0052 1168
W10M	-0.44366 0.0001 2500	-0.48919 0.0001 2401	0.04545 0.1176 1187	1.00000 0.0000 2540	0.60603 0.0001 2395	0.23410 0.0001 2500	0.32616 0.0001 2390	0.03215 0.1162 2390	0.47639 0.0001 2289	-0.47403 0.0001 2289	0.23556 0.0001 2296	-0.22610 0.0001 2296
W2M	-0.42377 0.0001 2635	-0.42183 0.0001 2622	0.00226 0.9374 1205	0.60603 0.0001 2395	1.00000 0.0000 2636	0.12193 0.0001 2636	0.32681 0.0001 2521	-0.05052 0.0112 2521	0.31785 0.0001 2394	-0.30408 0.0001 2394	0.04047 0.0472 2406	-0.02284 0.2628 2406
TEMP	-0.10734 0.0001 2740	-0.09353 0.0001 2641	-0.01525 0.5902 1250	0.23410 0.0001 2500	0.12193 0.0001 2636	1.00000 0.0000 2741	0.15648 0.0001 2626	0.83573 0.0001 2626	0.08079 0.0001 2491	-0.11938 0.0001 2491	0.33306 0.0001 2504	-0.32323 0.0001 2504
HUMID	-0.58336 0.0001 2625	-0.63085 0.0001 2526	-0.27647 0.0001 1224	0.32616 0.0001 2390	0.32681 0.0001 2521	0.15648 0.0001 2626	1.00000 0.0000 2626	-0.36725 0.0001 2626	0.36915 0.0001 2491	-0.43242 0.0001 2491	0.31869 0.0001 2504	-0.30108 0.0001 2504
DEWPT	0.18359 0.0001 2625	0.22649 0.0001 2526	0.15866 0.0001 1224	0.03215 0.1162 2390	-0.05052 0.0112 2521	0.83573 0.0001 2626	-0.36725 0.0001 2626	1.00000 0.0000 2626	-0.10315 0.0001 2491	0.08884 0.0001 2491	0.17100 0.0001 2504	-0.16849 0.0001 2504
AIR3TO5	-0.62115 0.0001 2490	-0.68803 0.0001 2411	-0.09652 0.0010 1167	0.47639 0.0001 2289	0.31785 0.0001 2394	0.08079 0.0001 2491	0.36915 0.0001 2491	-0.10315 0.0001 2491	1.00000 0.0000 2491	-0.92417 0.0001 2491	0.33131 0.0001 2482	-0.31751 0.0001 2482
EIR3TO5	0.65463 0.0001 2490	0.73469 0.0001 2411	0.11304 0.0001 1167	-0.47403 0.0001 2289	-0.30408 0.0001 2394	-0.11938 0.0001 2491	-0.43242 0.0001 2491	0.08884 0.0001 2491	-0.92417 0.0001 2491	1.00000 0.0000 2491	-0.50126 0.0001 2482	0.49692 0.0001 2482
AIR8TO12	-0.37632 0.0001 2503	-0.44200 0.0001 2423	-0.09727 0.0009 1168	0.23556 0.0001 2296	0.04047 0.0472 2406	0.33306 0.0001 2504	0.31869 0.0001 2504	0.17100 0.0001 2504	0.33131 0.0001 2482	-0.50126 0.0001 2482	1.00000 0.0000 2504	-0.97603 0.0001 2504
EIR8TO12	0.34235 0.0001 2503	0.42099 0.0001 2423	0.08166 0.0052 1168	-0.22610 0.0001 2296	-0.02284 0.2628 2406	-0.32323 0.0001 2504	-0.30108 0.0001 2504	-0.16849 0.0001 2504	-0.31751 0.0001 2482	0.49692 0.0001 2482	-0.97603 0.0001 2504	1.00000 0.0000 2504

NOVEMBER CORRELATION COEFFICIENTS / PROB > |R| UNDER HO:RHO=0 / NUMBER OF OBSERVATIONS

	ATT	EXT	CLOUD	W10M	W2M	TEMP	HUMID	DEWPT	AIR3TO5	EIR3TO5	AIR8TO12	EIR8TO12
ATT	1.00000 0.0000 2783	0.94623 0.0001 2772	0.18917 0.0001 1156	-0.36356 0.0001 2496	-0.30885 0.0001 2719	-0.23062 0.0001 2783	-0.71118 0.0001 2783	0.09572 0.0001 2783	-0.47862 0.0001 2517	0.42694 0.0001 2517	-0.37570 0.0001 2542	0.40731 0.0001 2542
EXT	0.94623 0.0001 2772	1.00000 0.0000 2845	0.18108 0.0001 1176	-0.37925 0.0001 2558	-0.31110 0.0001 2781	-0.18635 0.0001 2845	-0.75901 0.0001 2845	0.16027 0.0001 2845	-0.59804 0.0001 2587	0.56425 0.0001 2587	-0.43998 0.0001 2612	0.50252 0.0001 2612
CLOUD	0.18917 0.0001 1156	0.18108 0.0001 1176	1.00000 0.0000 1193	0.01794 0.5508 1108	0.05692 0.0531 1155	-0.02671 0.3585 1184	-0.26920 0.0001 1184	0.11576 0.0001 1184	-0.10421 0.0006 1078	0.06169 0.0429 1078	-0.10455 0.0006 1082	0.09787 0.0013 1082
W10M	-0.36356 0.0001 2496	-0.37925 0.0001 2558	0.01794 0.5508 1108	1.00000 0.0000 2570	0.71417 0.0001 2505	0.41879 0.0001 2569	0.38075 0.0001 2569	0.24378 0.0001 2569	0.29341 0.0001 2310	-0.28914 0.0001 2310	0.12426 0.0001 2333	-0.19949 0.0001 2333
W2M	-0.30885 0.0001 2719	-0.31110 0.0001 2781	0.05692 0.0531 1155	0.71417 0.0001 2505	1.00000 0.0000 2792	0.39209 0.0001 2792	0.36972 0.0001 2792	0.19742 0.0001 2792	0.19526 0.0001 2526	-0.18537 0.0001 2526	0.06718 0.0007 2551	-0.12060 0.0001 2551
TEMP	-0.23062 0.0001 2783	-0.18635 0.0001 2845	-0.02671 0.3585 1184	0.41879 0.0001 2569	0.39209 0.0001 2792	1.00000 0.0000 2856	0.17048 0.0001 2856	0.86257 0.0001 2856	0.24426 0.0001 2590	-0.24382 0.0001 2590	0.25246 0.0001 2615	-0.30983 0.0001 2615
HUMID	-0.71118 0.0001 2783	-0.75901 0.0001 2845	-0.26920 0.0001 1184	0.38075 0.0001 2569	0.36972 0.0001 2792	0.17048 0.0001 2856	1.00000 0.0000 2856	-0.30773 0.0001 2856	0.47893 0.0001 2590	-0.45799 0.0001 2590	0.32003 0.0001 2615	-0.37300 0.0001 2615
DEWPT	0.09572 0.0001 2783	0.16027 0.0001 2845	0.11576 0.0001 1184	0.24378 0.0001 2569	0.19742 0.0001 2792	0.86257 0.0001 2856	-0.30773 0.0001 2856	1.00000 0.0000 2856	0.05230 0.0078 2590	-0.06118 0.0018 2590	0.13201 0.0001 2615	-0.16283 0.0001 2615
AIR3TO5	-0.47862 0.0001 2517	-0.59804 0.0001 2587	-0.10421 0.0006 1078	0.29341 0.0001 2310	0.19526 0.0001 2526	0.24426 0.0001 2590	0.47893 0.0001 2590	0.05230 0.0078 2590	1.00000 0.0000 2590	-0.96211 0.0001 2590	0.73506 0.0001 2588	-0.78492 0.0001 2588
EIR3TO5	0.42694 0.0001 2517	0.56425 0.0001 2587	0.06169 0.0429 1078	-0.28914 0.0001 2310	-0.18537 0.0001 2526	-0.24382 0.0001 2590	-0.45799 0.0001 2590	-0.06118 0.0018 2590	-0.96211 0.0001 2590	1.00000 0.0000 2590	-0.70698 0.0001 2588	0.78782 0.0001 2588
AIR8TO12	-0.37570 0.0001 2542	-0.43998 0.0001 2612	-0.10455 0.0006 1082	0.12426 0.0001 2333	0.06718 0.0007 2551	0.25246 0.0001 2615	0.32003 0.0001 2615	0.13201 0.0001 2615	0.73506 0.0001 2588	-0.70698 0.0001 2588	1.00000 0.0000 2615	-0.91081 0.0001 2615
EIR8TO12	0.40731 0.0001 2542	0.50252 0.0001 2612	0.09787 0.0013 1082	-0.19949 0.0001 2333	-0.12060 0.0001 2551	-0.30983 0.0001 2615	-0.37300 0.0001 2615	-0.16283 0.0001 2615	-0.78492 0.0001 2588	0.78782 0.0001 2588	-0.91081 0.0001 2615	1.00000 0.0000 2615

DECEMBER CORRELATION COEFFICIENTS / PROB > |R| UNDER H0:RHO=0 / NUMBER OF OBSERVATIONS

	ATT	EXT	CLOUD	W10M	W2M	TEMP	HUMID	DEWPT	AIR3TO5	EIR3TO5	AIR8TO12	EIR8TO12
ATT	1.00000 0.0000 2725	0.94978 0.0001 2711	0.15241 0.0001 1037	-0.46165 0.0001 2616	-0.37337 0.0001 2725	-0.27446 0.0001 2725	-0.70150 0.0001 2725	0.01028 0.5916 2725	-0.30087 0.0001 2615	0.25987 0.0001 2615	-0.27490 0.0001 2635	0.22575 0.0001 2635
EXT	0.94978 0.0001 2711	1.00000 0.0000 2745	0.14813 0.0001 1037	-0.46175 0.0001 2636	-0.40236 0.0001 2745	-0.27282 0.0001 2745	-0.74450 0.0001 2745	0.03058 0.1092 2745	-0.41831 0.0001 2637	0.37971 0.0001 2637	-0.37438 0.0001 2657	0.32675 0.0001 2657
CLOUD	0.15241 0.0001 1037	0.14813 0.0001 1037	1.00000 0.0000 1110	0.03466 0.2660 1032	0.11872 0.0001 1048	0.03133 0.3109 1048	-0.23066 0.0001 1048	0.14597 0.0001 1048	-0.01359 0.6670 1005	0.00404 0.8981 1005	0.00074 0.9812 1007	-0.01524 0.6290 1007
W10M	-0.46165 0.0001 2616	-0.46175 0.0001 2636	0.03466 0.2660 1032	1.00000 0.0000 2651	0.71467 0.0001 2650	0.42071 0.0001 2650	0.43066 0.0001 2650	0.22721 0.0001 2650	0.12255 0.0001 2544	-0.09612 0.0001 2544	0.14037 0.0001 2564	-0.10831 0.0001 2564
W2M	-0.37337 0.0001 2725	-0.40236 0.0001 2745	0.11872 0.0001 1048	0.71467 0.0001 2650	1.00000 0.0000 2759	0.33354 0.0001 2759	0.42358 0.0001 2759	0.14894 0.0001 2759	0.08238 0.0001 2649	-0.06727 0.0005 2649	0.08822 0.0001 2669	-0.06911 0.0004 2669
TEMP	-0.27446 0.0001 2725	-0.27282 0.0001 2745	0.03133 0.3109 1048	0.42071 0.0001 2650	0.33354 0.0001 2759	1.00000 0.0000 2759	0.20959 0.0001 2759	0.89255 0.0001 2759	0.14241 0.0001 2649	-0.13443 0.0001 2649	0.28344 0.0001 2669	-0.29873 0.0001 2669
HUMID	-0.70150 0.0001 2725	-0.74450 0.0001 2745	-0.23066 0.0001 1048	0.43066 0.0001 2650	0.42358 0.0001 2759	0.20959 0.0001 2759	1.00000 0.0000 2759	-0.21331 0.0001 2759	0.30026 0.0001 2649	-0.27688 0.0001 2649	0.21623 0.0001 2669	-0.17467 0.0001 2669
DEWPT	0.01028 0.5916 2725	0.03058 0.1092 2745	0.14597 0.0001 1048	0.22721 0.0001 2650	0.14894 0.0001 2759	0.89255 0.0001 2759	-0.21331 0.0001 2759	1.00000 0.0000 2759	0.04654 0.0166 2649	-0.04764 0.0142 2649	0.21380 0.0001 2669	-0.24560 0.0001 2669
AIR3TO5	-0.30087 0.0001 2615	-0.41831 0.0001 2637	-0.01359 0.6670 1005	0.12255 0.0001 2544	0.08238 0.0001 2649	0.14241 0.0001 2649	0.30026 0.0001 2649	0.04654 0.0166 2649	1.00000 0.0000 2695	-0.97433 0.0001 2695	0.78124 0.0001 2693	-0.75084 0.0001 2693
EIR3TO5	0.25987 0.0001 2615	0.37971 0.0001 2637	0.00404 0.8981 1005	-0.09612 0.0001 2544	-0.06727 0.0005 2649	-0.13443 0.0001 2649	-0.27688 0.0001 2649	-0.04764 0.0142 2649	-0.97433 0.0001 2695	1.00000 0.0000 2695	-0.75303 0.0001 2693	0.75125 0.0001 2693
AIR8TO12	-0.27490 0.0001 2635	-0.37438 0.0001 2657	0.00074 0.9812 1007	0.14037 0.0001 2564	0.08822 0.0001 2669	0.28344 0.0001 2669	0.21623 0.0001 2669	0.21380 0.0001 2669	0.78124 0.0001 2693	-0.75303 0.0001 2693	1.00000 0.0000 2714	-0.96732 0.0001 2714
EIR8TO12	0.22575 0.0001 2635	0.32675 0.0001 2657	-0.01524 0.6290 1007	-0.10831 0.0001 2564	-0.06911 0.0004 2669	-0.29873 0.0001 2669	-0.17467 0.0001 2669	-0.24560 0.0001 2669	-0.75084 0.0001 2693	0.75125 0.0001 2693	-0.96732 0.0001 2714	1.00000 0.0000 2714

APPENDIX I

YPENBURG EXPONENTIAL DECAY FUNCTIONS

EXPONENTIAL DECAY FUNCTIONS AND REGRESSION COEFFICIENTS
YPENBURG VISUAL ATTENUATION (PER KM)

MONTH	A	B	EXP A	EXP B	EXP A+B	SE	EXP B-SE	EXP B+SE	EXP B-90%	EXP B+90%
JANUARY	-0.0352	-0.0440	0.9654	0.9570	0.9239	0.1250	0.8320	1.0820	0.7514	1.1626
FEBRUARY	-0.0300	-0.0499	0.9705	0.9513	0.9232	0.1242	0.8271	1.0755	0.7479	1.1556
MARCH	-0.0461	-0.0530	0.9549	0.9484	0.9056	0.1197	0.8286	1.0681	0.7514	1.1453
APRIL	-0.0558	-0.0574	0.9457	0.9442	0.8930	0.1130	0.8312	1.0572	0.7584	1.1300
MAY	-0.1029	-0.0490	0.9022	0.9522	0.8590	0.1213	0.8309	1.0735	0.7526	1.1517
JUNE	-0.0741	-0.0647	0.9286	0.9373	0.8704	0.1319	0.8054	1.0692	0.7203	1.1543
JULY	-0.0406	-0.0737	0.9602	0.9290	0.8920	0.0983	0.8306	1.0273	0.7672	1.0907
AUGUST	-0.0544	-0.0596	0.9471	0.9421	0.8922	0.1136	0.8285	1.0557	0.7552	1.1290
SEPTEMBER	-0.0209	-0.0757	0.9793	0.9271	0.9080	0.1034	0.8238	1.0305	0.7571	1.0971
OCTOBER	-0.0406	-0.0482	0.9603	0.9530	0.9151	0.1230	0.8299	1.0760	0.7506	1.1553
NOVEMBER	-0.0596	-0.0371	0.9422	0.9635	0.9078	0.1388	0.8248	1.1023	0.7353	1.1918
DECEMBER	-0.0643	-0.0361	0.9377	0.9646	0.9045	0.1422	0.8223	1.1068	0.7306	1.1985

PERIOD	ZEXP B	ZSE	ZEXP B-90%	ZEXP B+90%	EXP B	SE	EXP B-SE	EXP B+SE	EXP B-90%	EXP B+90%
D-J-F	2.0077	0.1432	1.7722	2.2432	0.9646	0.1422	0.8223	1.1068	0.7306	1.1985
M-A-M	1.8153	0.0684	1.7027	1.9278	0.9484	0.0683	0.8800	1.0167	0.8360	1.0607
J-J-A	1.7049	0.0652	1.5977	1.8122	0.9360	0.0651	0.8709	1.0011	0.8290	1.0431
S-O-N	1.8385	0.0706	1.7224	1.9546	0.9507	0.0705	0.8802	1.0211	0.8347	1.0666
YEAR	1.8238	0.0350	1.7662	1.8814	0.9492	0.0350	0.9142	0.9842	0.8916	1.0068

EXPONENTIAL DECAY FUNCTIONS AND REGRESSION COEFFICIENTS
YPENBURG VISUAL EXTINCTION (PER KM)

MONTH	A	B	EXP A	EXP B	EXP A+B	SE	EXP B-SE	EXP B+SE	EXP B-90%	EXP B+90%
JANUARY	-0.0957	-0.0495	0.9087	0.9517	0.8648	0.1187	0.8329	1.0704	0.7564	1.1469
FEBRUARY	-0.0566	-0.0527	0.9450	0.9486	0.8964	0.1222	0.8264	1.0708	0.7476	1.1496
MARCH	-0.0943	-0.0658	0.9100	0.9363	0.8520	0.1091	0.8272	1.0454	0.7569	1.1157
APRIL	-0.1207	-0.0797	0.8863	0.9234	0.8185	0.1030	0.8204	1.0264	0.7539	1.0929
MAY	-0.1713	-0.0573	0.8426	0.9444	0.7957	0.1164	0.8280	1.0608	0.7529	1.1353
JUNE	-0.1889	-0.0675	0.8279	0.9348	0.7739	0.1343	0.8004	1.0691	0.7138	1.1557
JULY	-0.0903	-0.0853	0.9137	0.9182	0.8390	0.1018	0.8164	1.0201	0.7508	1.0857
AUGUST	-0.1189	-0.0633	0.8879	0.9386	0.8334	0.1124	0.8262	1.0510	0.7538	1.1235
SEPTEMBER	-0.0879	-0.0726	0.9158	0.9300	0.8517	0.1173	0.8126	1.0473	0.7370	1.1230
OCTOBER	-0.0885	-0.0475	0.9153	0.9537	0.8729	0.1264	0.8272	1.0801	0.7457	1.1616
NOVEMBER	-0.1240	-0.0399	0.8833	0.9609	0.8488	0.1326	0.8283	1.0935	0.7428	1.1790
DECEMBER	-0.1243	-0.0355	0.8831	0.9651	0.8523	0.1431	0.8220	1.1082	0.7298	1.2004

PERIOD	ZEXP B	ZSE	ZEXP B-90%	ZEXP B+90%	EXP B	SE	EXP B-SE	EXP B+SE	EXP B-90%	EXP B+90%
D-J-F	2.0153	0.1440	1.7784	2.2522	0.9651	0.1431	0.8220	1.1082	0.7298	1.2004
M-A-M	1.7010	0.0635	1.5965	1.8055	0.9355	0.0634	0.8721	0.9990	0.8312	1.0399
J-J-A	1.6658	0.0664	1.5566	1.7750	0.9310	0.0663	0.8647	0.9973	0.8220	1.0400
S-O-N	1.8466	0.0736	1.7255	1.9677	0.9514	0.0735	0.8779	1.0249	0.8305	1.0723
YEAR	1.7838	0.0348	1.7265	1.8410	0.9451	0.0348	0.9103	0.9799	0.8879	1.0023

EXPONENTIAL DECAY FUNCTIONS AND REGRESSION COEFFICIENTS
YPENBURG AEROSOL INFRARED TRANSMISSION 3.4-5.0 MICRONS (%)

MONTH	A	B	EXP A	EXP B	EXP A+B	SE	EXP B-SE	EXP B+SE	EXP B-90%	EXP B+90%
JANUARY	-0.3862	-0.0724	0.6796	0.9302	0.6322	0.0998	0.8304	1.0299	0.7661	1.0943
FEBRUARY	-0.2009	-0.0928	0.8180	0.9114	0.7455	0.0933	0.8180	1.0047	0.7578	1.0649
MARCH	-0.3604	-0.0948	0.6974	0.9095	0.6343	0.0885	0.8211	0.9930	0.7640	1.0550
APRIL	-0.5311	-0.1068	0.5880	0.8987	0.5284	0.0897	0.8091	0.9884	0.7512	1.0463
MAY	-0.6370	-0.0824	0.5289	0.9209	0.4871	0.1192	0.8017	1.0401	0.7248	1.1170
JUNE	-0.7698	-0.0989	0.4631	0.9059	0.4195	0.1093	0.7965	1.0152	0.7260	1.0857
JULY	-0.5910	-0.0641	0.5538	0.9379	0.5194	0.1077	0.8301	1.0456	0.7607	1.1151
AUGUST	-0.6532	-0.0778	0.5204	0.9251	0.4814	0.1058	0.8193	1.0309	0.7511	1.0991
SEPTEMBER	-0.5590	-0.0806	0.5718	0.9226	0.5275	0.1116	0.8110	1.0342	0.7390	1.1061
OCTOBER	-0.3965	-0.0704	0.6726	0.9321	0.6269	0.1080	0.8240	1.0401	0.7543	1.1098
NOVEMBER	-0.4455	-0.0461	0.6405	0.9550	0.6116	0.1300	0.8249	1.0850	0.7411	1.1688
DECEMBER	-0.3823	-0.1138	0.6823	0.8925	0.6089	0.0814	0.8110	0.9739	0.7585	1.0264

PERIOD	ZEXP B	ZSE	ZEXP B-90%	ZEXP B+90%	EXP B	SE	EXP B-SE	EXP B+SE	EXP B-90%	EXP B+90%
D-J-F	1.4339	0.0816	1.2997	1.5681	0.8925	0.0814	0.8110	0.9739	0.7585	1.0264
M-A-M	1.5221	0.0560	1.4299	1.6142	0.9091	0.0559	0.8531	0.9650	0.8170	1.0011
J-J-A	1.6321	0.0628	1.5287	1.7354	0.9264	0.0627	0.8636	0.9891	0.8232	1.0296
S-O-N	1.7319	0.0679	1.6203	1.8436	0.9393	0.0678	0.8715	1.0071	0.8278	1.0508
YEAR	1.6061	0.0297	1.5572	1.6550	0.9226	0.0297	0.8929	0.9523	0.8737	0.9715

EXPONENTIAL DECAY FUNCTIONS AND REGRESSION COEFFICIENTS
YPENBURG EQUIVALENT INFRARED AEROSOL EXTINCTION 3.4-5.0 MICRONS (PER KM)

MONTH	A	B	EXP A	EXP B	EXP A+B	SE	EXP B-SE	EXP B+SE	EXP B-90%	EXP B+90%
JANUARY	-0.4103	-0.0669	0.6635	0.9353	0.6206	0.1038	0.8315	1.0391	0.7646	1.1060
FEBRUARY	-0.2122	-0.0940	0.8088	0.9102	0.7362	0.0927	0.8175	1.0030	0.7577	1.0628
MARCH	-0.3459	-0.0965	0.7076	0.9080	0.6425	0.0877	0.8203	0.9957	0.7638	1.0522
APRIL	-0.5816	-0.1086	0.5589	0.8971	0.5014	0.0889	0.8082	0.9860	0.7508	1.0433
MAY	-0.6088	-0.0909	0.5440	0.9131	0.4967	0.1136	0.7995	1.0267	0.7263	1.0999
JUNE	-0.8167	-0.1062	0.4419	0.8993	0.3974	0.1055	0.7937	1.0048	0.7257	1.0729
JULY	-0.5849	-0.0684	0.5572	0.9339	0.5203	0.1044	0.8295	1.0382	0.7623	1.1055
AUGUST	-0.6905	-0.0697	0.5013	0.9326	0.4676	0.1117	0.8209	1.0443	0.7489	1.1164
SEPTEMBER	-0.5841	-0.0824	0.5576	0.9209	0.5135	0.1103	0.8105	1.0312	0.7394	1.1023
OCTOBER	-0.4137	-0.0738	0.6612	0.9289	0.6142	0.1055	0.8234	1.0344	0.7553	1.1025
NOVEMBER	-0.4722	-0.0459	0.6236	0.9552	0.5956	0.1303	0.8248	1.0855	0.7408	1.1695
DECEMBER	-0.4294	-0.1125	0.6509	0.8936	0.5816	0.0819	0.8117	0.9754	0.7589	1.0282

PERIOD	ZEXP B	ZSE	ZEXP B-90%	ZEXP B+90%	EXP B	SE	EXP B-SE	EXP B+SE	EXP B-90%	EXP B+90%
D-J-F	1.4394	0.0820	1.3044	1.5743	0.8936	0.0819	0.8117	0.9754	0.7589	1.0282
M-A-M	1.5030	0.0549	1.4127	1.5934	0.9057	0.0549	0.8508	0.9606	0.8154	0.9960
J-J-A	1.6290	0.0626	1.5260	1.7320	0.9259	0.0626	0.8634	0.9885	0.8230	1.0288
S-O-N	1.7213	0.0672	1.6108	1.8317	0.9380	0.0671	0.8710	1.0051	0.8277	1.0483
YEAR	1.6021	0.0296	1.5534	1.6508	0.9220	0.0296	0.8924	0.9516	0.8733	0.9707

EXPONENTIAL DECAY FUNCTIONS AND REGRESSION COEFFICIENTS
YPENBURG AEROSOL INFRARED TRANSMISSION 8.0-12.0 MICRONS (%)

MONTH	A	B	EXP A	EXP B	EXP A+B	SE	EXP B-SE	EXP B+SE	EXP B-90%	EXP B+90%
JANUARY	-0.4659	-0.0900	0.6276	0.9139	0.5735	0.0891	0.8248	1.0031	0.7673	1.0605
FEBRUARY	-0.2730	-0.1039	0.7611	0.9013	0.6868	0.0876	0.8137	0.9889	0.7573	1.0453
MARCH	-0.4794	-0.0944	0.6192	0.9099	0.5634	0.0889	0.8210	0.9988	0.7636	1.0562
APRIL	-0.5335	-0.0707	0.5865	0.9318	0.5465	0.1102	0.8216	1.0420	0.7506	1.1130
MAY	-0.7419	-0.0627	0.4762	0.9392	0.4473	0.1362	0.8030	1.0754	0.7152	1.1632
JUNE	-0.8342	-0.0776	0.4342	0.9253	0.4018	0.1292	0.8021	1.0485	0.7226	1.1280
JULY	-0.6162	-0.0697	0.5400	0.9327	0.5036	0.1034	0.8293	1.0361	0.7626	1.1027
AUGUST	-0.7026	-0.0552	0.4953	0.9463	0.4687	0.1251	0.8212	1.0713	0.7405	1.1520
SEPTEMBER	-0.6018	-0.0440	0.5478	0.9570	0.5242	0.1506	0.8064	1.1075	0.7093	1.2046
OCTOBER	-0.4180	-0.0533	0.6584	0.9481	0.6242	0.1235	0.8246	1.0715	0.7450	1.1512
NOVEMBER	-0.4753	-0.0478	0.6217	0.9533	0.5927	0.1269	0.8264	1.0802	0.7446	1.1620
DECEMBER	-0.3612	-0.1077	0.6969	0.8979	0.6257	0.0833	0.8146	0.9811	0.7609	1.0348

PERIOD	ZEXP B	ZSE	ZEXP B-90%	ZEXP B+90%	EXP B	SE	EXP B-SE	EXP B+SE	EXP B-90%	EXP B+90%
D-J-F	1.4612	0.0834	1.3239	1.5984	0.8979	0.0833	0.8146	0.9811	0.7609	1.0348
M-A-M	1.6291	0.0624	1.5265	1.7317	0.9259	0.0623	0.8636	0.9883	0.8234	1.0284
J-J-A	1.7050	0.0675	1.5940	1.8161	0.9360	0.0674	0.8686	1.0035	0.8251	1.0469
S-O-N	1.8596	0.0769	1.7332	1.9861	0.9526	0.0767	0.8759	1.0293	0.8265	1.0788
YEAR	1.6671	0.0315	1.6152	1.7189	0.9312	0.0315	0.8997	0.9627	0.8793	0.9830

EXPONENTIAL DECAY FUNCTIONS AND REGRESSION COEFFICIENTS
YPENBURG EQUIVALENT INFRARED AEROSOL EXTINCTION 8.0-12.0 MICRONS (PER KM)

MONTH	A	B	EXP A	EXP B	EXP A+B	SE	EXP B-SE	EXP B+SE	EXP B-90%	EXP B+90%
JANUARY	-0.4791	-0.0890	0.6194	0.9149	0.5666	0.0897	0.8252	1.0045	0.7674	1.0624
FEBRUARY	-0.3113	-0.0984	0.7325	0.9063	0.6639	0.0900	0.8163	0.9963	0.7583	1.0543
MARCH	-0.4580	-0.1098	0.6326	0.8960	0.5668	0.0825	0.8135	0.9786	0.7603	1.0318
APRIL	-0.5368	-0.0620	0.5846	0.9399	0.5495	0.1175	0.8223	1.0574	0.7466	1.1332
MAY	-0.7247	-0.0812	0.4845	0.9220	0.4467	0.1199	0.8022	1.0419	0.7249	1.1191
JUNE	-0.8009	-0.0723	0.4489	0.9302	0.4176	0.1276	0.8026	1.0579	0.7203	1.1402
JULY	-0.5880	-0.0762	0.5555	0.9266	0.5147	0.0989	0.8277	1.0255	0.7640	1.0893
AUGUST	-0.7069	-0.0487	0.4932	0.9525	0.4697	0.1331	0.8194	1.0856	0.7335	1.1714
SEPTEMBER	-0.6485	-0.0511	0.5228	0.9502	0.4968	0.0991	0.8510	1.0493	0.7871	1.1132
OCTOBER	-0.4680	-0.0525	0.6262	0.9488	0.5942	0.1244	0.8244	1.0733	0.7442	1.1535
NOVEMBER	-0.5293	-0.0473	0.5890	0.9538	0.5618	0.1275	0.8263	1.0813	0.7440	1.1635
DECEMBER	-0.4232	-0.0921	0.6550	0.9120	0.5974	0.0960	0.8220	1.0020	0.7640	1.0601

PERIOD	ZEXP B	ZSE	ZEXP B-90%	ZEXP B+90%	EXP B	SE	EXP B-SE	EXP B+SE	EXP B-90%	EXP B+90%
D-J-F	1.5395	0.0902	1.3911	1.6879	0.9120	0.0900	0.8220	1.0020	0.7640	1.0601
M-A-M	1.5889	0.0599	1.4903	1.6874	0.9200	0.0599	0.8601	0.9798	0.8215	1.0184
J-J-A	1.7178	0.0684	1.6053	1.8303	0.9376	0.0683	0.8693	1.0059	0.8253	1.0499
S-O-N	1.8409	0.0666	1.7314	1.9504	0.9509	0.0665	0.8844	1.0174	0.8415	1.0602
YEAR	1.6778	0.0308	1.6271	1.7284	0.9326	0.0308	0.9018	0.9634	0.8819	0.9832

EXPONENTIAL DECAY FUNCTIONS AND REGRESSION COEFFICIENTS
YPENBURG 10M WIND SPEED (M/SEC)

MONTH	A	B	EXP A	EXP B	EXP A+B	SE	EXP B-SE	EXP B+SE	EXP B-90%	EXP B+90%
JANUARY	-0.1300	-0.0657	0.8781	0.9365	0.8223	0.1265	0.8099	1.0630	0.7283	1.1446
FEBRUARY	-0.0395	-0.0570	0.9612	0.9446	0.9080	0.1199	0.8247	1.0645	0.7474	1.1418
MARCH	-0.0421	-0.0595	0.9588	0.9422	0.9033	0.1192	0.8230	1.0614	0.7462	1.1382
APRIL	-0.1355	-0.0494	0.8733	0.9518	0.8312	0.1245	0.8273	1.0763	0.7470	1.1566
MAY	-0.1698	-0.0517	0.8438	0.9496	0.8013	0.1252	0.8244	1.0748	0.7437	1.1555
JUNE	-0.2595	-0.0557	0.7714	0.9458	0.7296	0.1480	0.7979	1.0938	0.7025	1.1892
JULY	-0.0983	-0.0729	0.9064	0.9297	0.8427	0.1033	0.8264	1.0331	0.7598	1.0997
AUGUST	-0.1105	-0.0529	0.8954	0.9484	0.8492	0.1213	0.8271	1.0697	0.7489	1.1479
SEPTEMBER	-0.1149	-0.0422	0.8915	0.9587	0.8546	0.1429	0.8158	1.1015	0.7237	1.1936
OCTOBER	-0.0704	-0.0541	0.9320	0.9473	0.8830	0.1207	0.8267	1.0680	0.7488	1.1458
NOVEMBER	-0.0978	-0.0395	0.9069	0.9613	0.8717	0.1403	0.8209	1.1016	0.7305	1.1921
DECEMBER	-0.0857	-0.0443	0.9178	0.9567	0.8781	0.1305	0.8262	1.0872	0.7421	1.1713

PERIOD	ZEXP B	ZSE	ZEXP B-90%	ZEXP B+90%	EXP B	SE	EXP B-SE	EXP B+SE	EXP B-90%	EXP B+90%
D-J-F	1.9055	0.1312	1.6896	2.1214	0.9567	0.1305	0.8262	1.0872	0.7421	1.1713
M-A-M	1.8133	0.0714	1.6959	1.9308	0.9482	0.0713	0.8769	1.0195	0.8309	1.0654
J-J-A	1.7492	0.0702	1.6338	1.8646	0.9413	0.0701	0.8712	1.0113	0.8260	1.0565
S-O-N	1.8982	0.0779	1.7700	2.0263	0.9561	0.0777	0.8784	1.0338	0.8282	1.0839
YEAR	1.8188	0.0366	1.7585	1.8790	0.9487	0.0366	0.9121	0.9853	0.8885	1.0089

EXPONENTIAL DECAY FUNCTIONS AND REGRESSION COEFFICIENTS
YPENBURG 2M WIND SPEED (M/SEC)

MONTH	A	B	EXP A	EXP B	EXP A+B	SE	EXP B-SE	EXP B+SE	EXP B-90%	EXP B+90%
JANUARY	-0.1046	-0.0547	0.9007	0.9467	0.8527	0.1122	0.8346	1.0589	0.7622	1.1312
FEBRUARY	-0.1318	-0.0398	0.8766	0.9610	0.8423	0.1389	0.8221	1.0998	0.7326	1.1894
MARCH	-0.1166	-0.0633	0.8899	0.9386	0.8353	0.1056	0.8330	1.0442	0.7649	1.1124
APRIL	-0.1372	-0.0441	0.8718	0.9569	0.8342	0.1288	0.8281	1.0856	0.7451	1.1686
MAY	-0.3172	-0.0275	0.7282	0.9728	0.7084	0.1612	0.8116	1.1340	0.7077	1.2380
JUNE	-0.5461	-0.0546	0.5792	0.9469	0.5484	0.1573	0.7896	1.1041	0.6882	1.2055
JULY	-0.2231	-0.0470	0.8000	0.9541	0.7632	0.1225	0.8315	1.0766	0.7525	1.1556
AUGUST	-0.2519	-0.0468	0.7773	0.9543	0.7418	0.1276	0.8267	1.0819	0.7445	1.1641
SEPTEMBER	-0.3705	-0.0309	0.6904	0.9696	0.6694	0.1710	0.7986	1.1406	0.6884	1.2508
OCTOBER	-0.2017	-0.0502	0.8173	0.9510	0.7773	0.1205	0.8305	1.0715	0.7528	1.1492
NOVEMBER	-0.0731	-0.0274	0.9295	0.9730	0.9044	0.1591	0.8139	1.1321	0.7113	1.2346
DECEMBER	-0.0842	-0.0474	0.9193	0.9537	0.8767	0.1234	0.8302	1.0771	0.7507	1.1567

PERIOD	ZEXP B	ZSE	ZEXP B-90%	ZEXP B+90%	EXP B	SE	EXP B-SE	EXP B+SE	EXP B-90%	EXP B+90%
D-J-F	1.8709	0.1241	1.6668	2.0750	0.9537	0.1234	0.8302	1.0771	0.7507	1.1567
M-A-M	1.9240	0.0753	1.8000	2.0479	0.9582	0.0752	0.8830	1.0334	0.8346	1.0819
J-J-A	1.8603	0.0776	1.7327	1.9879	0.9527	0.0774	0.8753	1.0301	0.8254	1.0800
S-O-N	2.0221	0.0859	1.8807	2.1634	0.9656	0.0857	0.8798	1.0513	0.8245	1.1066
YEAR	1.9209	0.0387	1.8572	1.9847	0.9580	0.0387	0.9193	0.9967	0.8943	1.0217

EXPONENTIAL DECAY FUNCTIONS AND REGRESSION COEFFICIENTS
YPENBURG DEWPOINT (DEG C)

MONTH	A	B	EXP A	EXP B	EXP A+B	SE	EXP B-SE	EXP B+SE	EXP B-90%	EXP B+90%
JANUARY	-0.0181	-0.0589	0.9820	0.9428	0.9259	0.1001	0.8346	1.0509	0.7649	1.1207
FEBRUARY	-0.0356	-0.0427	0.9650	0.9582	0.9247	0.1341	0.8241	1.0923	0.7376	1.1788
MARCH	0.0109	-0.0448	1.0109	0.9562	0.9666	0.1255	0.8306	1.0817	0.7497	1.1627
APRIL	-0.0043	-0.0364	0.9957	0.9643	0.9601	0.1416	0.8226	1.1059	0.7313	1.1972
MAY	-0.0374	-0.0247	0.9633	0.9756	0.9398	0.1702	0.8654	1.1458	0.6957	1.2556
JUNE	-0.1906	-0.0743	0.8265	0.9284	0.7673	0.1255	0.8029	1.0539	0.7220	1.1349
JULY	-0.0447	-0.0281	0.9562	0.9723	0.9298	0.1608	0.8115	1.1332	0.7078	1.2369
AUGUST	-0.0382	-0.0387	0.9625	0.9621	0.9260	0.1464	0.8157	1.1085	0.7213	1.2029
SEPTEMBER	0.0106	-0.0409	1.0106	0.9599	0.9701	0.1511	0.8088	1.1109	0.7114	1.2083
OCTOBER	-0.0194	-0.0280	0.9808	0.9724	0.9536	0.1646	0.8077	1.1370	0.7016	1.2431
NOVEMBER	-0.0197	-0.0228	0.9805	0.9774	0.9584	0.1739	0.8035	1.1513	0.6914	1.2635
DECEMBER	-0.0127	-0.0270	0.9874	0.9734	0.9611	0.1631	0.8103	1.1365	0.7052	1.2416

PERIOD	ZEXP B	ZSE	ZEXP B-90%	ZEXP B+90%	EXP B	SE	EXP B-SE	EXP B+SE	EXP B-90%	EXP B+90%
D-J-F	2.1532	0.1645	1.8826	2.4238	0.9734	0.1631	0.8103	1.1365	0.7052	1.2416
M-A-M	2.0325	0.0840	1.8943	2.1707	0.9663	0.0838	0.8824	1.0501	0.8283	1.1042
J-J-A	1.9556	0.0859	1.8144	2.0968	0.9608	0.0856	0.8751	1.0464	0.8199	1.1016
S-O-N	2.1194	0.0959	1.9616	2.2772	0.9716	0.0957	0.8759	1.0672	0.8142	1.1289
YEAR	2.0132	0.0427	1.9429	2.0834	0.9649	0.0427	0.9223	1.0076	0.8948	1.0351

EXPONENTIAL DECAY FUNCTIONS AND REGRESSION COEFFICIENTS
YPENBURG RELATIVE HUMIDITY (100% - RH)

MONTH	A	B	EXP A	EXP B	EXP A+B	SE	EXP B-SE	EXP B+SE	EXP B-90%	EXP B+90%
JANUARY	-0.0285	-0.0897	0.9719	0.9142	0.8885	0.0878	0.8264	1.0020	0.7698	1.0586
FEBRUARY	0.0706	-0.1117	1.0731	0.8943	0.9597	0.0833	0.8110	0.9776	0.7573	1.0313
MARCH	-0.0028	-0.1155	0.9972	0.8909	0.8884	0.0785	0.8124	0.9694	0.7618	1.0200
APRIL	-0.0516	-0.1004	0.9497	0.9045	0.8590	0.0857	0.8188	0.9902	0.7636	1.0454
MAY	-0.1489	-0.0618	0.8616	0.9400	0.8100	0.1082	0.8318	1.0482	0.7621	1.1180
JUNE	-0.1455	-0.0832	0.8646	0.9201	0.7955	0.1185	0.8016	1.0387	0.7252	1.1151
JULY	-0.1934	-0.0626	0.8242	0.9393	0.7742	0.1082	0.8311	1.0476	0.7613	1.1173
AUGUST	-0.1695	-0.0839	0.8441	0.9195	0.7761	0.0998	0.8197	1.0193	0.7553	1.0837
SEPTEMBER	-0.1627	-0.0785	0.8498	0.9245	0.7856	0.1095	0.8150	1.0340	0.7444	1.1046
OCTOBER	-0.0928	-0.0959	0.9113	0.9086	0.8280	0.0896	0.8189	0.9982	0.7612	1.0560
NOVEMBER	-0.0796	-0.0731	0.9235	0.9295	0.8584	0.0979	0.8316	1.0274	0.7685	1.0905
DECEMBER	-0.0605	-0.0690	0.9413	0.9333	0.8785	0.1025	0.8308	1.0358	0.7647	1.1019

PERIOD	ZEXP B	ZSE	ZEXP B-90%	ZEXP B+90%	EXP B	SE	EXP B-SE	EXP B+SE	EXP B-90%	EXP B+90%
D-J-F	1.6836	0.1029	1.5144	1.8528	0.9333	0.1025	0.8308	1.0358	0.7647	1.1019
M-A-M	1.5530	0.0520	1.4674	1.6386	0.9143	0.0520	0.8623	0.9663	0.8288	0.9998
J-J-A	1.6454	0.0629	1.5418	1.7489	0.9282	0.0629	0.8654	0.9911	0.8248	1.0316
S-O-N	1.5982	0.0570	1.5045	1.6919	0.9214	0.0569	0.8645	0.9783	0.8278	1.0150
YEAR	1.5868	0.0279	1.5410	1.6327	0.9197	0.0279	0.8918	0.9475	0.8738	0.9655

EXPONENTIAL DECAY FUNCTIONS AND REGRESSION COEFFICIENTS
YPENBURG TEMPERATURE (DEG. C)

MONTH	A	B	EXP A	EXP B	EXP A+B	SE	EXP B-SE	EXP B+SE	EXP B-90%	EXP B+90%
JANUARY	-0.0222	-0.0506	0.9780	0.9507	0.9298	0.1166	0.8340	1.0673	0.7580	1.1425
FEBRUARY	-0.0787	-0.0290	0.9244	0.9715	0.8980	0.1624	0.8090	1.1339	0.7043	1.2386
MARCH	-0.0580	-0.0432	0.9437	0.9577	0.9037	0.1277	0.8300	1.0854	0.7477	1.1677
APRIL	-0.2432	-0.0645	0.7841	0.9376	0.7351	0.1074	0.8302	1.0449	0.7610	1.1141
MAY	-0.0869	-0.0182	0.9168	0.9820	0.9003	0.1976	0.7844	1.1797	0.6569	1.3071
JUNE	-0.0835	-0.0480	0.9199	0.9531	0.8768	0.1531	0.8001	1.1062	0.7014	1.2049
JULY	-0.1030	-0.0325	0.9022	0.9680	0.8733	0.1470	0.8210	1.1150	0.7262	1.2097
AUGUST	-0.1263	-0.0436	0.8813	0.9573	0.8437	0.1321	0.8253	1.0894	0.7401	1.1746
SEPTEMBER	-0.0854	-0.0430	0.9182	0.9579	0.8796	0.1463	0.8117	1.1042	0.7174	1.1985
OCTOBER	-0.0590	-0.0264	0.9427	0.9739	0.9181	0.1654	0.8085	1.1393	0.7019	1.2460
NOVEMBER	-0.0327	-0.0146	0.9678	0.9855	0.9538	0.2160	0.7695	1.2015	0.6302	1.3408
DECEMBER	-0.0158	-0.0225	0.9843	0.9778	0.9624	0.1782	0.7996	1.1559	0.6847	1.2708

PERIOD	ZEXP B	ZSE	ZEXP B-90%	ZEXP B+90%	EXP B	SE	EXP B-SE	EXP B+SE	EXP B-90%	EXP B+90%
D-J-F	2.2437	0.1801	1.9474	2.5399	0.9778	0.1782	0.7996	1.1559	0.6847	1.2708
M-A-M	1.9972	0.0812	1.8636	2.1308	0.9638	0.0811	0.8828	1.0449	0.8305	1.0972
J-J-A	1.9586	0.0838	1.8208	2.0965	0.9610	0.0836	0.8774	1.0446	0.8235	1.0985
S-O-N	2.2045	0.1033	2.0346	2.3745	0.9760	0.1030	0.8730	1.0789	0.8066	1.1453
YEAR	2.0563	0.0442	1.9836	2.1290	0.9678	0.0442	0.9236	1.0120	0.8951	1.0403

APPENDIX J

YPENBURG STEPWISE COEFFICIENTS OF DETERMINATION

YPENBURG STEPWISE COEFFICIENTS OF DETERMINATION FOR DEPENDENT VARIABLE EQUIVALENT IR AEROSOL EXTINCTION 3.4-5.0 MICRONS AT THE .15 SIGNIFICANCE LEVEL

JANUARY

R SQUARED	VARIABLE(S) ENTERED
.2940	RH
.3091	RH, DP
.3147	T, RH, DP
.3160	2M, T, RH, DP

FEBRUARY

R SQUARED	VARIABLE(S) ENTERED
.0719	T
.0842	10M, T
.0859	10M, T, DP
.0891	10M, T, RH, DP

MARCH

R SQUARED	VARIABLE(S) ENTERED
.2261	RH
.2500	RH, DP
.2536	2M, RH, DP

APRIL

R SQUARED	VARIABLE(S) ENTERED
.1798	RH
.2047	2M, RH
.2083	2M, RH, DP
.2170	2M, T, RH, DP

MAY

R SQUARED	VARIABLE(S) ENTERED
.0604	RH
.0753	T, RH
.0819	T, RH, DP
.0871	10M, T, RH, DP

JUNE

R SQUARED	VARIABLE(S) ENTERED
.0401	DP
.0632	10M, DP
.0824	10M, 2M, DP

JULY

R SQUARED	VARIABLE(S) ENTERED
.1484	RH
.1605	T, RH
.1690	T, RH, DP
.1720	10M, T, RH, DP

AUGUST

R SQUARED	VARIABLE(S) ENTERED
.1271	RH
.1343	2M, RH
.1381	2M, RH, DP
.1770	2M, T, RH, DP

SEPTEMBER

R SQUARED	VARIABLE(S) ENTERED
.2578	RH
.2611	T, RH
.2678	T, RH, DP

OCTOBER

R SQUARED	VARIABLE(S) ENTERED
.1028	RH
.1075	T, RH
.1152	T, RH, DP
.1204	10M, T, RH, DP

NOVEMBER

R SQUARED	VARIABLE(S) ENTERED
.2412	RH
.2560	10M, RH
.2610	10M, RH, DP
.2891	10M, T, RH, DP

DECEMBER

R SQUARED	VARIABLE(S) ENTERED
.0981	RH
.1033	RH, DP
.1122	T, RH, DP
.1144	2M, T, RH, DP

YPENBURG STEPWISE COEFFICIENTS OF DETERMINATION FOR DEPENDENT VARIABLE
EQUIVALENT IR AEROSOL EXTINCTION 8 - 12 MICRONS AT THE .15 SIGNIFICANCE LEVEL

JANUARY

R SQUARED	VARIABLE(S) ENTERED
.1399	RH
.2042	RH, DP
.2107	T, RH, DP
.2118	2M, T, RH, DP

FEBRUARY

R SQUARED	VARIABLE(S) ENTERED
.0380	DP
.0475	2M, DP

MARCH

R SQUARED	VARIABLE(S) ENTERED
.1294	RH
.1555	10M, RH
.1844	10M, RH, DP
.1989	10M, T, RH, DP

APRIL

R SQUARED	VARIABLE(S) ENTERED
.0468	RH
.0787	RH, DP
.0920	T, RH, DP
.0938	2M, T, RH, DP

MAY

R SQUARED	VARIABLE(S) ENTERED
.0839	RH
.0906	RH, DP
.1131	T, RH, DP

JUNE

R SQUARED	VARIABLE(S) ENTERED
.0342	T
.0465	2M, T
.0637	2M, T, DP

JULY

R SQUARED	VARIABLE(S) ENTERED
.1203	RH
.1627	RH, DP
.1701	T, RH, DP
.1731	10M, T, RH, DP

AUGUST

R SQUARED	VARIABLE(S) ENTERED
.1501	T
.1693	T, RH
.2259	T, RH, DP
.2289	2M, T, RH, DP

SEPTEMBER

R SQUARED	VARIABLE(S) ENTERED
.1544	T
.2238	T, RH
.2352	T, RH, DP

OCTOBER

R SQUARED	VARIABLE(S) ENTERED
.1272	T
.2029	T, RH
.2211	T, RH, DP
.2309	2M, T, RH, DP

NOVEMBER

R SQUARED	VARIABLE(S) ENTERED
.1064	RH
.1840	RH, DP
.2179	10M, RH, DP
.2267	2M, T, RH, DP

DECEMBER

R SQUARED	VARIABLE(S) ENTERED
.0879	T
.1104	T, RH
.1349	10M, T, RH
.1377	10M, T, RH, DP

YPENBURG STEPWISE COEFFICIENTS OF DETERMINATION FOR DEPENDENT VARIABLE VISUAL EXTINCTION AT THE .15 SIGNIFICANCE LEVEL

JANUARY

R SQUARED	VARIABLE(S) ENTERED
.4710	RH
.5592	2M, RH .478110M, RH
.5388	2M, T, RH
.5446	10M, 2M, T, RH

FEBRUARY

R SQUARED	VARIABLE(S) ENTERED
.3842	RH
.4781	10M, RH
.4917	10M, RH, DP
.4934	10M, T, RH, DP

MARCH

R SQUARED	VARIABLE(S) ENTERED
.2185	RH
.3056	2M, RH
.3069	10M, 2M, RH

APRIL

R SQUARED	VARIABLE(S) ENTERED
.2269	RH
.2903	2M, RH
.3131	2M, T, RH
.3405	10M, 2M, T, RH

MAY

R SQUARED	VARIABLE(S) ENTERED
.2637	RH
.3534	RH, DP
.4218	10M, RH, DP
.4268	10M, T, RH, DP

JUNE

R SQUARED	VARIABLE(S) ENTERED
.2777	DP
.4062	10M, DP
.4388	10M, RH, DP

JULY

R SQUARED	VARIABLE(S) ENTERED
.3216	DP
.4463	RH, DP
.4700	10M, RH, DP
.4853	10M, T, RH, DP

AUGUST

R SQUARED	VARIABLE(S) ENTERED
.1882	RH
.2848	2M, RH
.3500	2M, T, RH
.3971	10M, 2M, T, RH

SEPTEMBER

R SQUARED	VARIABLE(S) ENTERED
.2695	RH
.3609	T, RH
.4363	10M, T, RH
.4553	10M, 2M, T, RH

OCTOBER

R SQUARED	VARIABLE(S) ENTERED
.3803	RH
.4789	10M, RH
.4922	10M, T, RH
.4989	10M, 2M, T, RH

NOVEMBER

R SQUARED	VARIABLE(S) ENTERED
.5805	RH
.5901	10M, RH
.5923	10M, RH, DP
.5946	10M, T, RH, DP

DECEMBER

R SQUARED	VARIABLE(S) ENTERED
.3850	RH
.4441	T, RH
.4646	10M, T, RH

ABBREVIATIONS, ACRONYMS, AND SYMBOLS

aa	aerosol absorption
AFGL	Air Force Geophysics Laboratory
AFGWC	Air Force Global Weather Central
as	aerosol scattering
AWS	Air Weather Service
b_λ	monochromatic volume attenuation/extinction coefficient
CDF	Cumulative Distribution Function
D	path length over which extinction occurs.
DNY	The Environmental Simulation Section of USAFETAC.
e	vapor pressure
e_s	saturation vapor pressure
$E[\cdot]$	Expectation operator
END	Equivalent Normal Deviate, the standard normal variable.
EO	Electro-Optical.
EO/Met	Electro-Optical and Meteorological.
EOMETS1	The environmental simulation model of a single EO/Met variable at some initial time and at N lag times.
EOMETS2	The environmental simulation model on N EO/Met variables at a time lag Δt in which the cross correlations between the N EO/Met variables are preserved.
GMT	Greenwich Mean Time
IR	Infrared
I_λ	intensity of the incident monochromatic radiation
km	kilometer
km^{-1}	per kilometer
L	latent heat of vaporization
log	common logarithm, base 10
ln	natural logarithm, base e
ma	molecular absorption
Met	Meteorological
ms	molecular scattering
$mm\ hr^{-1}$	millimeters per hour
$msec^{-1}$	meters per second
MST	Mean Solar Time
MULTRI	Multivariate Triangular Matrix Simulation model
nm	nautical mile

OPA	Optical Physics Division of AFGL
OPAQUE	Optical Atmospheric Quantities in Europe
P	total atmospheric pressure
PDF	Probability Density Function
R	radius of scattering or absorption particle
R_λ	spectral response of a sensor
RH	relative humidity
R_{mv}	specific gas constant for water vapor
T	temperature
T_D	dewpoint temperature
USAFETAC	United States Air Force Environmental Technical Applications Center
V1S1	Single-variable, single station environmental simulation model
V2S1	Two-variable, single station environmental simulation model
$W_{\lambda,t}$	radiance of a transmitting source
X_o	path length for a given radiance
τ_λ	Monochromatic transmittance
λ	wavelength
$\bar{\beta}$	weighted average extinction
τ_{aer}	transmittance for aerosols
τ_{H_2O}	transmittance for water vapor
τ_{mol}	transmittance for molecular components
τ_{meas}	measured Barnes transmittance

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